Sensory properties and consumer acceptance of orange-fleshed sweet potato bread: the effect of food neophobia

By

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DECLARATION

I declare that the dissertation herewith submitted for the degree of MSc Food Science at the University of Pretoria has not been previously submitted by me for a degree at any other university or institution of higher education.

Annelize Steyn
Date: 2022/08/01

DEDICATION

This dissertation is dedicated to God who placed me on this journey for a purpose and for providing me with strength and hope. I dedicate this dissertation to my Mother and Father, who taught me that you can achieve anything with hard work. To Ulrich Müller for inspiring me to go on even when it felt like my world was caving in. To everyone that helped and supported me along the way, your love and kindness did not go unnoticed.

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ABSTRACT

Sensory properties and consumer acceptance of orange-fleshed sweet potato bread: the effect of food neophobia

By

Annelize Steyn

Supervisor: Prof. H.L. de Kock

A considerable effort is placed on developing food products for food-insecure environments. Vitamin A deficiency is a problem that is plaguing the nutrition security of many consumers in Sub-Saharan Africa. Nutrition security requires the intake of a wide range of foods which provides all the essential needed nutrients. Vitamin A is essential for immune function, eye and vision health and skeletal growth. To address this problem bread that is high in β-carotene (a precursor of vitamin A) was developed by partially replacing part of the wheat flour and water in a standard formulation with orange-fleshed sweet potato (OFSP) puree. In this dissertation, the term OFSP bread will be used to refer to this wheat and OFSP composite bread. Many new food products such as this one fail in the market. One of the reasons why new food products fail is due to consumers' fear of the novelty e.g. sensory properties that are different to what the consumers are used to. Food neophobia is the term that is used to describe "the reluctance to eat or the avoidance of unfamiliar foods" (Pliner and Hobden, 1992). Understanding consumers' food neophobic attitudes can assist in the development of products that meet the consumers' needs. Food neophobia is generally measured using the Food Neophobia Scale (FNS) developed by Pliner and Hobden (1992). In this study, sensory properties of the OFSP bread had to be determined. In addition, the effect of food neophobia on consumer acceptance of the OFSP bread

This study investigated whether research participants' food neophobia scores could serve as a predictor for (1) the likelihood of choosing unfamiliar foods and (2) expected liking of the sensory properties of unfamiliar products including OFSP bread. The project consisted of two phases. Phase 1: an online survey to determine the effect of food neophobia (measured with an adapted FNS) on participants' consisting of

liking/expected liking of a selection of familiar and unfamiliar foods and the likelihood of choosing the options. Phase 2: This phase consisted of physico (L^*, a^* and b^* colour values, instrumental texture and image analysis) and descriptive sensory (with trained sensory panel) characterisation of the different bread types. In addition consumer evaluation of standard familiar wheat bread and the bread containing the unfamiliar ingredient (OFSP) was conducted.

As expected, the food neophobic score of participants did affect whether they expected to like or dislike and were likely to choose and unfamiliar food item. The results showed that individuals with higher food neophobia scores were expected to dislike and were more reluctant to choose unfamiliar food items than low neophobic individuals. The food neophobia score of participants can therefore serve as a predictor of their willingness to try unfamiliar foods. However, contrary to expectations consumers with high food neophobia did not rate the liking of the sensory properties of the unfamiliar OFSP bread lower than consumers with low food neophobia scores.

Food neophobia did not play a significant role in whether the OFSP bread was liked or disliked. The finding can be explained as follows: the sensory properties of the OFSP bread, except for the colour, were as acceptable as the wheat bread to the consumers that participated in the research probably because the OFSP bread had very similar sensory properties to the wheat bread.

This research concludes that food neophobia is indeed a reliable predictor of the potential of consumers to accept novel food products. However, the extent of the novelty of the sensory properties of a new product is an important factor in the neophobic effect. The OFSP bread can be introduced into the market with a low risk of rejection of the sensory properties even by individuals with high food neophobia tendencies. Regular consumption of OFSP bread has the potential to reduce vitamin A deficiency among affected individuals and communities. Further research is required to determine if food neophobic individuals will choose a labelled and branded OFSP bread option within a real market situation where novel and familiar wheat bread options are offered side by side. More research on other food product options to address vitamin A deficiency using OFSP or other applications.

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INTRODUCTION

The growing food market has resulted in pioneering developments in food innovation, resulting in various new products (Bäckström, Pirttilä-Backman and Tuorila, 2004) with various benefits for consumers, including for consumers in developing countries (Rollin, Kennedy and Wills, 2011). Projects like InnoFoodAfrica develop new products with sustainable plant-based ingredients to minimise malnutrition in African countries while empowering smallholder farms (InnoFoodAfrica, 2021). New products have a failure rate of around 70-80% (Gresham, Hafer and Markowski, 2006). Market failures can be due to ambivalence or insecurity associated with new products (Grunert and Valli, 2001; Rollin, Kennedy and Wills, 2011). The success of new food items and new food technologies is linked the behavioural responses of consumers to the new foods and innovation. An individual's attitude towards food influences their food choices. Food neophobia (FN) is "the reluctance to eat or the avoidance of novel or unfamiliar foods" (Pliner and Hobden, 1992). The food neophobia scale (FNS) developed by Pliner and Hobden (1992) measures an individual's reluctance to try unfamiliar foods. Unwillingness to consume unfamiliar foods can lead to a decrease in diversity and quality in the diet of individuals, with healthier individuals tending to have a more diverse diet (Jaeger, Roigard, Hunter, and Worch, 2021b).

A considerable proportion of the African population currently lives in food-insecure environments, with limited access to nutritious, safe and culturally appropriate foods (Ramaroson Rakotosamimanana and De Kock, 2020). Considerable effort is placed on addressing the sustainability, safety, cost, and nutritional quality of food for the disadvantaged; however, research that focuses on the willingness to try such food solutions is sometimes lacking (Ramaroson Rakotosamimanana and De Kock, 2020). One such nutrition intervention food product is orange-fleshed sweet potato (OFSP) bread where wheat flour and water are partially replaced with OFSP puree, which is naturally high in β- carotene (a vitamin A precursor) (Owade, Abong and Okoth, 2018). A food company approached the research team with a request to determine the consumer acceptance of the sensory properties of the new OFSP bread with 30% replacement of wheat and water. Vitamin A deficiency plagues sub-Saharan Africa (Tomlins, Ndunguru, Stambul, Joshue, Ngendello, Rwiza, Amour, Ramadhani, Kapande and Westby, 2007). According to the World Health Organisation (WHO,

2009), more than 190 million preschool children and 19 million pregnant women are globally affected by vitamin A deficiency. More than 40% of children under five suffer from vitamin A deficiency in sub-Saharan Africa (Black, Victoria, Walker, Bhutta, Christian, de Onis, Ezzati, Grantham-McGregor, Katz, Martorell and Uauy, 2013). Vitamin A deficiency is mainly caused by insufficient intake of vitamin A-rich food, malabsorption of vitamin A and loss due to illness (Sommer and West, 1996). The OFSP bread developers aim to decrease the vitamin A deficiency in the African population. However, the acceptance of the OFSP bread needs to be established.

FN measurement has scarcely been used in Africa, with research focusing on the willingness to try novel foods in more affluent countries, e.g. Canada, Australia and New Zealand (Damsbo-Svendsen, Frøst, and Olsen, 2017). The effects of food neophobia on a new product developed, e.g. OFSP bread must be established to ensure the successful implementation of nutritional intervention strategies. The OFSP bread requires consumer evaluation to determine if the product will be accepted/rejected i.e. the potential of adoption by the market. The OFSP bread also requires characterisation using sensory evaluation and other physical methods to determine the effects of the replacement of a portion of wheat and water with OFSP puree on the bread's sensory characteristics. A comparison of the OFSP bread with a familiar, consumer-accepted standard on the market can indicate the relative acceptance and potential of the new product.

LITERATURE REVIEW

This literature review will discuss food neophobia, the Food Neophobia Scale (FNS) and concerns with the FNS. The principle of food neophobia will be explored, giving insight into the African context. The socio-economic impact of food neophobia on consumers' health will be explored. Vitamin A deficiency and the potential of orange-fleshed sweet potato bread as a nutritional intervention strategy will be discussed. Sensory evaluation and other methods for bread characterisation will be reviewed. Finally, a general conclusion and identification of the areas in which further research effort is needed will be made.

Food neophobia

Willingness to consume and accept novel food alternatives involves overcoming significant barriers like disgust, food neophobia, demographic, cultural and socio-economic factors (Tuorila and Hartmann, 2020). Disgust is an essential mental disposition related to food neophobia. It forms part of an individual's behavioural system. Disgust provokes avoidance behaviours to prevent contact and ingestion of potentially harmful agents (Chapman and Anderson, 2012). Different factors can elicit disgust, e.g. the texture and appearance of food, ingredients' origins, personality traits and cultural views. An individual's susceptibility to being disgusted by food can hinder unfamiliar food items' acceptance, whereas food neophobia is widely accepted and an undisputed barrier to trying novel foods (Tuorila and Hartmann, 2020).

Food neophobia, both a personality trait and a state, is the personal reluctance or resistance to consuming foods that seem novel or new to the consumer (Henriques, King and Meiselman, 2009). The food items may contain new ingredients (Nguyen, Johnson, Jeffery, Danner and Bastian, 2019) or can be manufactured using new technologies (Henson, 1995). Trait refers to how individuals think, feel and behave across similar situations based on their characteristics, while state refers to how an individual think, feels and behaves in an actual situation at a specific time (Eysenk, 1983).

Food neophobia can be explained through the omnivore dilemma. Omnivorous animals face a dilemma regarding approaching or avoiding new foods. Avoiding unfamiliar foods is a protective function towards potentially hostile food environments, as these foods can be dangerous (Pliner and Hobden, 1992). In contrast, individuals (approach) explore unfamiliar foods to fulfil nutritional requirements (Lenglet, 2018). Avoiding unfamiliar foods is a persistent behavioural response, and food neophobia is typically regarded as a stable trait (Jaeger *et al*., 2021b).

Food neophobia manifest from childhood and plays a role in consumers' experimentation with food, thereby restricting experiences with various types of foods (Pliner and Pelchat, 1991; Knaapila, Tuorila, Silventoinen, Keskitalo, Kallela, Wessman, Peltonen, Cherkas, Spector and Perola, 2007; King and Meisleman, 2009; Cooke, 2018). It can be affected by age (Ritchey *et al*., 2003; Meiselman, King and Gillette, 2010), gender (Nordin, Broman, Garvill and Nyroos, 2004; Johns, Edwards and Hartwell, 2011), culture, an individual's country of origin and whether a person was raised in a rural or urban setting (Flight, Lepard and Cox, 2003; Ritchey *et al*., 2003; Olabi, Najm, Baghadi and Morton, 2009; Johns *et al.,* 2011).

Measuring food neophobia as a personality trait can be done using various instruments (Table 0.1), with some specifically designed to measure food neophobia in children (Damsbo-Svendsen *et al.*, 2017). Measuring food neophobia as a state is best done through task-orientated research, e.g. consumer product evaluation, to test participants' willingness to try unfamiliar foods (Martins, Pelchat and Pliner, 1997; McFarlane and Pliner, 1997; Pliner and Stallberg-White, 2000; Rigal *et al.*, 2006). The task-oriented food neophobia test is usually completed after a familiarity test, where participants are asked to rate how familiar a product is to them. The task-oriented food neophobia test is used to validate individuals' food neophobia scores, as neophobic individuals are supposed to be less willing to try unfamiliar foods (Tuorila, Lähteenmäki, Pohjalainen and Lotti, 2001).

It is good to establish familiarity with the product before determining the food item's willingness to try (Damsbo-Svendsen *et al.*, 2017). In general, the more familiar a consumer is with a product, the more willing they will be to try the particular food item (Tuorila *et al*., 2001).

Table 0.1 Examples of studies that used various instruments to measure willingness to try novel or new foods

Name of instrument	Measurement outcomes
Food Neophobia Scale (FNS) (Pliner and Hobden, 1992)	To determine how willing an individual will be to try new/novel foods.
Food Attitude Scale (FAS) (Frank and van der Klaaw, 1994)	To determine individuals' attitudes towards food and eating and their willingness to try new foods.
Variety Seeking Tendency Scale (VARSEEK) (Van Trjip and Steenkamp, 1992)	To determine the tendency of the individual to seek variety in terms of food and beverage choices. Lenglet (2018) suggested that this scale should be used to measure neophilia
Food and Eating Questionnaire (FEQ) (Raudenbush, van der Klaauw and Frank, 1995)	A combination of five instruments to determine preferences, attitudes and willingness to try foods
Food Technology Neophobia Scale (Cox and Evans, 2008)	Measures the willingness to consume foods produced via new food technologies.
FNS and Domain-Specific Innovativeness (DSI) Scale (Goldsmith and Hofacker, 1991; de Barcellos, Aguiar, Ferreira and Viera, 2009)	It measures the willingness to try and use innovative foods/ beverages within a specific product category. It was used to determine the willingness to purchase a new/novel product.
FNS + General Neophobia Scale (GNS) + Food Technology Neophobia Scale (FTNS) (Cox and Evans, 2008; Evans, Kermarrec, Sable and Cox, 2010; Pliner and Hobden, 1992)	To determine the impact of possible aspects between food neophobia and willingness to consume new/novel products. It measures neophobia concerning technology (FTNS), personality traits (GNS) and food neophobic (FNS)
Food Neophobia Questionnaire (FNQ) + Changing Neophobic Behaviour + Food Presentation Situations (Rubio, Rigal, Boireau-Ducept, Mallet and Meyer, 2008)	To determine children's willingness to taste novel foods and evaluates the different typologies of food neophobia using pictures of the food in various presentation contexts. To determine the choice of novel foods and the rated willingness to try novel foods among children.
Children's Eating Behaviour Questionnaire (CEBQ) (Wardle, Guthrie, Sanderson and Rapoport, 2001)	To measure children's eating behaviour rated by their parents
Fruit and Vegetable Neophobia Instrument (FVNI) (Hollar, Paxton-Aiken and Fleming, 2013)	To determine children's willingness to consume vegetables and fruits.
Food Neophobia Scale for Children (FNSC) (Rubio *et al*., 2008)	Choice of and rated willingness to try novel/ unfamiliar and familiar foods
Food Situation Questionnaire (FSQ) (Loewen and Pliner, 2000)	Children's willingness to eat novel/ unfamiliar food in different situations. It can indicate how children's approach to food changes in different situations.
Teachers administered Taste Test Tool (TTT) (Kaiser, Schneider, Mendoza, George, Neelon, Roche and Ginsburg, 2012)	Teachers measure children's and adolescents' willingness to try specific foods.
Will Try Instrument (Thomson, McCabe-Sellers, Strickland, Lovera, Nuss, Yadrick, Duke and Bogle, 2010)	Children's willingness to try both familiar and unfamiliar vegetables and fruits

Item- refers to either a question or statement.
Adapted from Damsbo-Svendsen *et al.*, (2017)

Food Neophobia Scale (FNS)

Food neophobia has been shown to accurately predict consumers' responses to novel food (Ritchey, Frank, Hursti and Tuorila, 2003). The FNS (Pliner and Hobden, 1992) is the most common method used to measure food neophobia as a personality trait in individuals (Rigal, Frelut, Monneuse, Hladik, Simmen and Pasquet, 2006; Damsbo-Svendsen *et al*., 2017). It appears to be the most popular method to characterise consumers based on their willingness or resistance to try unfamiliar foods (Ritchey *et al*., 2003: Damsbo-Svendsen *et al*., 2017; Cooke, 2018). The FNS was developed 30 years ago by Pliner and Hobden (1992) in Canada. It is based on a 10-item classic paper and pencil instrument (Table 0.2). The questionnaire consists of five statements 'not in favour of' and five reverse-scored statements 'in favour of' novelty, resulting in a balanced number of statements. The reverse score concept was developed to prevent individuals from responding to all the questions similarly (Gehlbach and Brinkworth, 2011). The ten statements are rated on a 7-point Likert scale ranging from 'disagree strongly' to 'agree strongly'. Individuals' scores are based on the mean score for the ten questions. The participants are grouped into low, medium/neutral or high neophobic categories based on these scores. Different techniques for calculating the food neophobia scores have been developed. Research shows that a high score on the scale indicates that the person is hesitant to try novel foods (Tuorila *et al*., 2001), and individuals with a low neophobic score tend to show a greater willingness to consume novel food items (Nolden and Hayes, 2017; Lenglet, 2018; Jaeger *et al*., 2021b). The FNS plays an essential role for various reasons. It can be used to determine the effect of food neophobia on dietary variety and human health (Jaeger, Rasmussen and Prescott, 2017), in new product development and reformulation (Ravadán *et al*., 2021) and in sensory analysis studies (Reverdy *et al*., 2008).

Table 0.2 Ten statements of the Food Neophobia Scale (FNS)

Item	Statements
1	I am constantly sampling new and different foods. (R)
2	I don't trust new foods.
3	If I don't know what is in my food, I won't try it.
4	I like foods from different countries. (R)
5	Ethnic foods look weird to eat.
6	At dinner parties, I will try new food. (R)
7	I am afraid to eat things I have never had before

Table 2.2 Ten statements of the Food Neophobia Scale (FNS)

Item	Statements
8	I am very particular about the foods I will eat.
9	I will eat almost anything. (R)
10	I like to try new ethnic restaurants. (R)

Pliner and Hobden (1992)
(R)-Statements for which scoring is reversed

Concerns about the FNS

Various research studies focusing on food neophobia have been done since the FNS was developed and validated almost 30 years ago by Pliner and Hobden (1992). The FNS was developed in Canada and validated in western cultures (Tuorila and Hartmann, 2020), where it was based on qualitative studies investigating consumers' conceptualisation of food neophobia (Ares, 2018). The FNS was initially used with Canadian university students, with a mean age of 20.67y (Pliner and Hobden, 1992). The scale received a Cronbach alpha score of 0.7. A score of 0.7 or higher indicates acceptable reliability and internal consistency of a multiple-question Likert scale survey (Tavakol and Dennick, 2011). The Cronbach alpha score indicates how closely related a set of test items are as a group. Various other FNS studies reported respectable reliability coefficients, but this does not imply unidimensionality for the scale, nor does it legitimize its use for cross-national comparisons (Ritchey *et al*., 2003).

There is limited research on food neophobia in the African context, particularly the use of the FNS as a means of measurement. Rabadán and Bernabéu (2021) found few studies conducted in Eastern Europe, Africa, or the Middle East. Difficulties surface when a scale developed and evaluated in a specific population is used worldwide (Ritchey *et al*., 2003). Different cultures might interpret the verbal statements differently compared to how the statements were developed and validated (Ritchey *et al*., 2003; Ares, 2018). For example, the wording of three items (5, 6 and 10) (Table *0.2*) could potentially be misconstrued by respondents due to the referencing of ethnic foods and dinner parties (Elkins and Zickgraf, 2018; Lenglet, 2018; Rabadán and Bernabéu, 2021). The referencing toward 'ethnic' can also be seen as culturally inappropriate (Lenglet, 2018).

Some researchers believe that statements 3, 8 and 9 (Table *0.2*) do not appear to refer to food neophobia in the strictest sense. These statements do not discriminate between picky/ fussy eaters, food neophobics, vegans/vegetarians and individuals who are suffering from food intolerances or allergies (Dematte, Endrizzi, Biasolle, Corollaro, Pojer, Zampini, Aprea and Gasperi, 2013; Guidetti, Carraro, Cavazza and Roccato, 2018; Lenglet, 2018). The FNS assumes that new/ novel foods are broadly accessible, whereas they are not available in certain cultures and environments. Certain statements also refer to 'liking', implying that the consumer has already tasted it and, therefore, it is no longer seen as novel.

There is no standardized method for categorising individuals into low, medium or high neophobic groups, as studies divide FNS participants into either two (Pliner and Hobden, 1992; Henriques *et al*., 2009; Olabi, Neuhaus, Bustos, Cook-Camacho, Corvi and Abdouni, 2015), three (Tuorila *et al*., 2001; Jaeger *et al*., 2021b), or six categories (Jaeger, Chheang, Jin, Ryan and Worch, 2021a). The majority of studies use the sample mean± SD score of the FNS to divide the participants into three groups' low, medium and high neophobic groups.

Low neophobic > (mean-standard deviation),

(Mean-standard deviation) $\leq$ Medium neophobic $\geq$ (mean + standard deviation) and

(mean+ standard deviation) < High neophobic

(Tuorila *et al*., 2001).

The participants can also be divided into two groups, low and high neophobic, by dividing the participants on their FNS scores, or classifying the participants as low neophobic when they score below 35 and high neophobic when they score above 35 (Henriques *et al*., 2009) or to classify participants as food neophobic when they scored 20 or higher on the FNS (Henriques *et al*., 2009). The lack of a standardized method for determining the groups can result in different researchers interpreting the same results in different manners and reaching different conclusions.

Modifications to the FNS have been proposed to increase its use for different countries and environments, such as changing the wording of certain statements (Reverdy, Chesnel, Schlich, Köster and Lange, 2008; Elkins and Zickgraf, 2018), changing the Likert scale (Henriques *et al*., 2009; Meiselman *et al*., 2010; Maes, Bourgonjon, Gheysen and Valcke, 2018), adding more items to the scale when comparing different

countries and cultures (Ritchey *et al*., 2003) or removing certain statements in the FNS (Ritchey *et al*., 2003; Sogari, Menozzi and Mora, 2019). Ritchey *et al*. (2003) proposed that items 5 and 9 (Table *0.2*) be removed due to the statements' poor fit in a unidimensional model and because the statements are too general. While Schnettler, Crisóstomo, Sepúlveda, Mora, Lobos, Miranda and Grunert (2013) recommended removing items 2, 3 and 8 (Table *0.2*) due to low communality values. Whereas Guidetti *et al*. (2018) proposed the removal of items 3, 4, 8 and 9 (Table *0.2*) after the revised scale with six items was validated among 711 Italian adults. However, it is unlikely to develop a verbal statement scale that serves the purpose of all the countries around the world and independently of time. The decrease in the mean food neophobic score in the last 20 years in Finland can be an indication of how the scale is dependent of time (Meiselman, Mastroianni, Buller, and Edwards, 1998 ; Tuorila *et al*., 2001; Knaapila *et al*., 2007; Tuorila, Huotilainen, Lähteenmäki, Ollila, Tuomi-Nurmi, and Urala, 2008; Knaapila *et al*., 2011; Vaarno, Niinikoski, Kaljonen, Aromaa, and Lagström, 2015; Knaapila, Laaksonen, Virtanen, Yang, Lagström, and Sandell, 2017 ; Elorinne, Niva, Vartiainen, and Väisänen, 2019; Rabadán and Bernabéu, 2021). There also exists a potential language barrier with the FNS, as it was created for English speaking countries. If not correctly translated, translation of the question can result in confusion, misinterpretation and risks (Ritchey *et al*., 2003). One should also consider potential biases from using only the English version or translated questionnaires in areas where multiple languages are spoken.

The structure of the FNS was always believed to consist of a single construct, the 'avoidance or reluctance' to eat novel and unfamiliar foods (Tuorila *et al*., 2001; Ritchey *et al*., 2003; Jaeger *et al*., 2017). However, various studies have also proposed that it consists of two latent constructs, related to 'approach or interest' and the 'avoidance or disinterest' in new foods (Nezlek, Forestell and Cypryanska, 2021). The two opposing tendencies, 'approach and avoidance', are better in understanding the response to novel foods when discussing the dimensionality of FNS (Nezlek *et al*., 2021). The FNS does not measure what its developers initially claimed it measured and does not generate a single score. The FN score is calculated by reverse scoring five of the ten questions; however, this technique automatically assumes that the reverse of approaching new foods is avoidance. The FNS does not consider that the opposite answer to the approach can be multidimensional and that just because

individuals do not want to try new foods it does not mean they are averse to trying new foods (Nezlek *et al*., 2021). Another study conducted in China found that FNS cannot be regarded as unidimensional because the scale presents three dimensions: willingness to try new foods, trust in new foods and food pickiness (Zhao, Gaoa, Li, Wanga, Zhang and Zou, 2020).

Cinar, Karinen and Tyber, 2021 also suggested that food neophobia cannot be regarded as a unidimensional concept because individuals' food neophobia score varies between meat and plant food items because they apply different psychological variables. Different food categories have different expected risks and benefits presented by them. Cinar *et al*. (2021) found that men scored lower in terms of meat neophobia when compared to women. There was no difference between the men and women regarding plant neophobia scores. It was concluded that a mixed-effect model between meat and plant neophobia is differentially related to several variables; pathogen sensitivity, animal empathy and masculinity (Cinar *et al*., 2021). It shows that food neophobia cannot be seen as a valuable unidimensional test if the food neophobia score will not produce a general individual score.

Hunger levels of the participants also affect the food neophobia score. Pliner *et al*. (1995) indicated that participants' food neophobia scores could increase if they were hungry, while Cinar *et al*. (2021) showed a decrease in participants' scores when they were experimentally manipulated to be hungry. Indicating that researchers can get varying results if they do not control the environment and conditions in which the participants conduct the test. A lack of set standards for the test conditions for the FNS can result in researchers obtaining different results.

Socio-economic factors and food neophobia

To avoid malnourishment, an individual must follow a diverse, balanced diet to ensure adequate nutrient intake. Consequently, individuals who consume a wider variety of foods tend to be healthier (Sarin, Taba, Fischer, Esko, Kanerva, Moilanes, Saltevo, Joensuu, Borodulin, Männisto, Kristiansson and Perola, 2019).

Food neophobic individuals are more prone to restricted dietary variety and inadequate nutrient intake (Cooke, Wardle and Gibson, 2003; Galloway, Lee and Birch, 2003; MacNicol, Murray and Austin, 2003; Cooke, Carnell and Wardle, 2006; Knaapila, Silventoinen, Broms, Rose, Perola, Kaprio and Tuorila, 2011; Siegrist, Hartmann and Keller, 2013; Knaapila, Sandell, Vaarno, Hoppu, Puolimatka, Kaljoen and Lagström, 2015; Jaeger *et al*., 2017). The willingness of an individual to implement dietary changes is affected by their food neophobia (Raudenbush and Frank, 1999). Food neophobic individuals generally consume a low variety of fruits and vegetables, with lower consumption of fruit and vegetables being linked to increased risk of cardiovascular disease (Joshipura, Hu, Mason, Stampfer, Rimm, Speizer *et al.,* 2001). Jaeger *et al*. (2021b) found a negative correlation between healthy food choices and food neophobia. Individuals with lower income have decreased liking for vegetables and increased food neophobia (Prescott, Young, O'neill, Yau and Stevens, 2002; Meiselman *et al*., 2010; Schnettler *et al*., 2013; Jaeger *et al.* 2017; Rabadán and Bernabéu, 2021). Lower-income groups already have an increased risk of obesity and associated non-communicable diseases (Bowman, 2007), with more food neophobic individuals having a higher body mass index (BMI) (Knaapila *et al*., 2015). Food neophobia places another burden on lower-income groups regarding health and nutrition, resulting in health complications that could have been avoided.

High food neophobia individuals are less willing to try new, ethnic, and unfamiliar foods (Tuorila *et al*., 2001; Roβbach, Foterek, Schmidt, Hilbig and Alexy, 2016; Jaeger *et al*., 2017; Jaeger *et al*., 2019) and typically give lower hedonic responses for food and beverages compared to low neophobic individuals (Jaeger, Roigard, Le Blond, Hedderley and Giacalone, 2019; Olabi *et al*., 2015). High food neophobic individuals' failure to accept unfamiliar food items contributes to product failure and the high market failure rate of new food and beverage items. The success of new food items and new food technologies depends on consumers' behavioural responses toward unfamiliar food items and new food technologies (Chen, Anders and An, 2013). Therefore, it is essential to understand why individuals accept or reject new and unfamiliar foods and identify population segments that are more or less neophobic. Understanding consumers' neophobic status can provide data regarding their emotional responses toward new and novel food items. This can be used to inform food product development teams on improvements to achieve a better market success

rate of new products, to help in the successful implementation of nutritional intervention strategies and help in better marketing strategies for the products (Evans *et al*., 2010; Chen *et al*., 2013). Populations' food neophobic state can indicate just how aggressive marketing campaigns should be to assess whether free sample tastings and free coupons should be provided to enhance product familiarity with consumers.

The importance of food neophobia for Africa

More than 820 million people suffer from hunger worldwide, with many consumers in African countries making up this number (Ramaroson Rakotosamimanana and De Kock, 2020). This is partly due to insufficient access to food to sustain their daily requirements for nutrients. Food insecurity in these nations occurs due to the lack of physical and economic access to adequate amounts of nutritious, safe and culturally appropriate food to sustain a healthy and active life (Ramaroson Rakotosamimanana and De Kock, 2020). There is a justified interest in investigating food neophobia among populations in African countries due to the environment being challenged by the double burden of malnutrition (EAT-Lancet commission report, 2019). Information regarding food neophobia among consumers in Africa is seriously lacking, with only one study conducted in South Africa (Rabadán and Bernabéa, 2021). Strategies to incorporate new foods and nutrition interventions in African countries will benefit from a better understanding of food neophobic tendencies and the willingness to try new foods.

There is vast income inequality in African countries (World Inequality Lab, 2019) and high levels of low-quality education (UNDP Africa, 2017). The report stated that up to 50% of school children in African countries are not learning effectively, with only 4% of children in Africa expected to enrol in a graduate and postgraduate institution (UNDP Africa, 2017). There is a negative correlation between education level and income with food neophobia (Prescott *et al*., 2002; Meiselman *et al*., 2010; Schnettler *et al*., 2013; Jaeger *et al*., 2017; Rabadán and Bernabéu, 2021). Food neophobia scores are expected to vary in African countries due to the varying economic status and education levels.

Consumers in African countries also face unique challenges, e.g. socio-demographic and lifestyle factors which are not commonly encountered in other more developed countries where food neophobia is generally studied (Chen *et al*., 2013; De Steur, Odongo and Gellynck, 2016). Examples of this can be seen in a study conducted in Uganda, which found distance to market, marital status and household size play a significant role in food technology neophobia (De Steur *et al*., 2016). The markets in developing countries usually only operate weekly or monthly, and the markets are located far from rural living areas' (De Steur *et al*., 2016); this can be problematic as unfamiliar and novel food items are usually only sold in supermarkets. Marital status and household size influence food neophobia in developing countries more than in developed countries (De Steur *et al*., 2016). Researchers found that married respondents and larger households are more likely to reject new products based on price and instead follow their traditional food patterns, often perceived as healthier (Dimitri and Dettermann, 2012; De Steur *et al*., 2019).

Sub-Saharan Africa's constant food shortages and poverty levels limit food choices (Clover, 2003). Individuals cannot risk purchasing unfamiliar food items because they cannot guarantee that it will sustain them in the same was as their usual familiar food items will, and avoiding hunger is their main priority. This shows that economically vulnerable individuals' main priority in food selection is affordability and if it will 'alleviate hunger' and that sensory quality might be of lesser importance (Clover, 2003). It was shown that low-income consumers are quality driven (Gittelsohn and Sharm, 2009; Xazela, Hugo, Marume and Muchenhe, 2017) because grocery items make up a considerable proportion of their disposable income and, these consumers can thus not afford to replace products, as compared to consumers with a higher disposable income (Laestadius and Wolfson, 2019). When low-income consumers consider the sensory quality of a product they would rather prioritize their emotional well-being over the nutritional quality of the product (Gittelsohn and Sharm, 2009; Forde, 2018). Thus different motives play a role in whether a customer will be willing to purchase and consume a product or not. Many consumers in African countries can be more food neophobic because they cannot afford to try new food items as these might fail their requirements. Consumer food choice motives are related to food neophobia scores (Jaeger *et al*., 2017).

Siegrist and Hartmann (2020) determined that it is problematic to generalize findings between different countries regarding food neophobia when they observed a significant disparity in FN between the different countries. The study was the only study that included FN measurement in an African country, namely South Africa, by evaluating the acceptance level of lab-cultured meat in ten different countries. Siegrist and Hartmann (2020) mentioned that the high cultural diversity among the population in countries like South Africa, England and Mexico might be the reason why these countries are more open to novel foods. Consumers in countries like France are highly neophobic, possibly because of the importance of food traditions and culinary heritage. Consumers' food choices are affected by their culture, and it affects their attitudes and beliefs about food and the role it plays in their lives (Ares, 2018).

Vitamin A deficiency

Over the years, there has been a formidable rise in global malnutrition cases caused by the rise in the human population and decrease in primary resources, such as farmable land and freshwater. Malnutrition describes the deficiency, imbalance or excess of nutrients that result in a measurable adverse response to body composition, function and long-term health; it can refer to under or over nourishment (Saunders and Smith, 2010). Malnutrition is not just the over-or-under consumption of carbohydrates, lipids and proteins but includes micronutrients. Micronutrients refer to vitamins and minerals required in the body in tiny amounts. Micronutrients play a vital role in the normal functioning of the human body system, despite being an insignificant energy source (Min, Zhoa, Slivka and Wang, 2019). Micronutrient malnutrition, e.g. vitamin A deficiency, creates a global health risk (Ohanenye, Emenike, Mensi, Medina-Godoy, Jin, Ahmed, Sun and Udenigwe, 2021). More than half of the current global micronutrient malnutrition cases occur in sub-Saharan Africa (Ohanenye *et al*., 2021).

Vitamin A is required for maintaining a robust immune function, eye and vision health and skeletal growth (Rice, West and Black, 2004). A prolonged vitamin A deficiency can result in xerophthalmia and eventually death. Xerophthalmia is a preventable form of blindness caused by conjunctival and corneal xerosis, keratomalacia, nyctalopia and retinopathy (Sommer and West, 1996). Vitamin A is required to activate the signalling process in the retina that initiates vision and synthesises RNA and

glycoproteins required for corneal and conjunctival epithelial maintenance in the eye (Smith and Steinemann, 2000). The leading cause of early childhood death and a significant risk for pregnant and lactating women is vitamin A deficiency (Tomlins *et al*., 2007). Vitamin A deficiency can affect the severity rate of measles, diarrhoea, malaria and other infectious diseases in children and mothers, frequently plaguing African and Asian countries (Rice *et al*., 2004).

Micronutrients, e.g. vitamin A are also lost by simple processing methods, e.g. cooking. The loss of micronutrients creates a trade-off between the benefits of food processing and the eradication of micronutrient malnutrition in vulnerable populations. One method to offset this was the implementation of food fortification. Food fortification refers to a process where a food product's nutritional and health benefits are improved by adding an essential micronutrient with minimal risk to health (Dary and Hurrel, 2006). Staple foods like rice, maize and wheat flour are commonly fortified in sub-Saharan Africa with vitamins and minerals (Ohanenye *et al*., 2021). However, adding the vitamin can impact how much is bioavailable for the consumer. Humans can absorb 90% of vitamin A from fortified food; however, ± 40% can be lost during food processing and storage due to the vitamin sensitivity to light and oxygen (Ohanenye *et al*., 2021). Several staple foods, e.g. rice and cassava, can be biofortified with vitamin A (Ohanenye *et al*., 2021).

Orange-fleshed sweet potatoes

Sweet potato (*Ipomoea batatas*) originated from the Americas and was brought to Africa in the 1500s. It is a starchy seasonal perishable tuber that can be grown in multiple countries in Africa. Sweet potato is a reasonably drought-tolerant crop, and this is why it is seen as a food security crop in sub-Saharan Africa (Low, Mwanga, Andrade, Carey and Ball, 2017). The sweet potato crop will grow even if the maize crop fails. Sweet potatoes are commonly consumed boiled, steamed or fried and can be served for breakfast, lunch, as a snack or dinner.

Sweet potatoes are high in calories, rich in minerals (e.g. potassium, phosphorus and copper), vitamins (e.g. vitamin C, K, E, and several B-vitamins) and dietary fibre (Rodriguez-Amaya, 2010; Low *et al*., 2017). Multiple varieties of sweet potatoes are

available, with the flesh coming in multiple colours; white, cream, yellow, orange and purple. However, OFSP types contain large amounts of the antioxidant β-carotene (Rodriguez-Amaya, 2010), which is a precursor to vitamin A. One molecule of β-carotene is converted into two molecules of vitamin A (Weber and Gruner, 2012). Levels of β-carotene in sweet potatoes can vary from 5.091µg/100g to 27.698 µg/100g for OFSP, depending on the cultivar and variety (Islam, Nusrat, Begum and Ahsan, 2016). The β-carotene content is higher in the sweet potato with a more intense orange colour. OFSP has been recommended for the reduction of vitamin A deficiency.

However, sweet potato is thought of as a crop for the poor and is bulky, with the consumption per capita in urban areas frequently being lower than in rural areas (Low *et al*., 2017). The misperception of sweet potatoes as a poor man's food resulted in the development of bread containing orange-fleshed sweet potatoes to address vitamin A deficiency in African countries (Low *et al*., 2017). The OFSP bread is also more "convenient" and urban consumers prefer foods in "convenient" processed forms, which entails reduce preparation times or food that can be consumed immediately (Bocher, Low, Muoki, Magnaghi and Muzhingi, 2017).

Bread is an important staple ingredient consumed all over the world and provides important sources of nutrients e.g. carbohydrates, protein, fibre, minerals and vitamins (Owada *et al*., 2018). It is a fermented confectionary product made primarily from wheat flour, water, salt and sometimes yeast by a series of processes: mixing, kneading, proofing, shaping and baking (FAO, 1994; Mondal and Datta, 2008). A variety of bread baking techniques, food ingredients (e.g. food additives or functional food additives) and recipes are used of worldwide (Altunkaya, Hedegaard, Brimer, Gökmen and Skibsted, 2013). Bread production has evolved in terms of the ingredients used, e.g. composite flours, to produce bread that has improved sensory acceptability and physical-chemical quality. Phenolic compounds are an important part of the human diet. Phenolic compounds appear as naturally occurring antioxidants, these compounds have been reported to have a diverse set of beneficial bio-activities: anti-allergenic, anti-inflammatory, anti-mutagenic and antiviral properties (Altunkaya *et al.,* 2013). New bread formulations are thus developed to enhance the phenolic antioxidative content. Natural phenolic antioxidants can be incorporated into bread

with the use of fruits and vegetables, to offer health benefits. An example of this is the partial replacement of wheat flour and water with OFSP puree.

The incorporation of OFSP puree has resulted in the development of bread with increased β-carotene content. The OFSP puree also enriches the bread with fibre, minerals (e.g. calcium, phosphorous and zinc) and vitamins (e.g. vitamin B and C) (Owade, Abong and Okoth, 2018). The bread requires at least a wheat flour substitution of 30% OFSP puree to provide a significant β-carotene level (1.33mg/100g meeting approximately 21% of daily requirements) (Foodstuffs, Cosmetics and Disinfectants act, 1972, Act No.54 of 1972; Sindi, Kirimi and Low, 2013; Owade *et al*., 2018). The OFSP puree is produced by peeling, boiling/steaming and mashing the root which retain more than 90% of the β-carotene (Malavi, Mbogo, Moyo, Mwauru, Low and Muzhingi, 2022). Commercial OFSP puree is then rapidly sterilized with the use of a flow microwave system and aseptic packaging, which results in a shelf-stable, high quality, puree of at least 12 months (Bocher *et al*., 2017). However, this process is expensive and patented. A cheaper alternative consisted of preservatives and vacuum packaged puree that was shelf-stable at 23˚C for four months (Bocher *et al*., 2017). A profitable puree was produced by not peeling the roots, resulting in a puree with increased iron, zinc and dietary fibre. (Bocher *et al*., 2017). Shelf-stable OFSP puree is convenient as not all bakeries want to make their puree and bakeries do not always have the infrastructure to keep the puree refrigerated or frozen. Bread manufactured with OFSP puree has more desirable qualities in terms of shelf-life, moisture content, water activity, texture, microbial growth and cost than compared to OFSP flour (Bocher *et al*., 2017; Owade *et al*., 2018)

OFSP bread has economic and nutritional advantages, as the bread can target the medium and high-end markets that previously did not have access to OFSP and its benefits (Sindi *et al*., 2013). The introduction of OFSP puree in bread can promote domestic agriculture, by supporting high yielding local plant species. The partial replacement of wheat with OFSP puree can result in a decrease in bread costs because the majority of wheat is imported from other countries and is dependent on the exchange rate (FAO, 2020). Africa is mainly reliant on other countries for the supply of wheat and can be affected by political disruptions and supply chain problems. Like the recent increase in wheat prices caused by the military invasion of

Russia in Ukraine in 2022. Russia and Ukraine account for 30% of the global wheat trade (FAO, 2020). The international restrictions imposed on Russia have also impacted the fertilizer industry, as Russia supplies a great volume of fertilizer to the world which can impact the crop yields of other countries (FAO, 2020).

The addition of novel functional compounds derived from climate-smart crops must be developed and commercialised to improve the nutritional content, functionality and safety of foods. Using natural ingredients containing antioxidants e.g. β-carotene may be beneficial as an antioxidant source in biofortified food products without giving rise to quality defects (Altunkaya *et al*., 2013).However, it must be established if the bread containing the unfamiliar ingredient (OFSP) will be accepted/rejected by consumers to ensure successful acceptance by the market.

Sensory analysis of bread

Sensory analysis refers to the "scientific discipline used to evoke, measure, analyse and interpret reactions to the characteristics of foods and other materials as perceived by the human senses" (Stone and Sidel, 2004). Food sensory attributes are generally perceived as appearance, odour/aroma, sound texture and flavour. These attributes tend to be experienced simultaneously during consumption. To fully understand the effects of replacing wheat flour with OFSP puree requires that the bread undergo sensory and instrumental analyses to help determine how the products differ and provide a possible explanation of the level of product acceptance by consumers. Sensory evaluation of bread can contribute to the quality assessment of the OFSP bread and could be used to improve the OFSP bread. Sensory perception of a product plays an essential role in understanding consumer preference and potential purchase intent.

Descriptive sensory analysis of bread

Instrumental measurements, e.g. with a texture analyser and colourimeter, can provide valuable information regarding the texture and colour quality of products. Instrumental measurements can be costly and only measure one sensory characteristic of the product, whereas consumers base their hedonic ratings of

products on multiple sensory characteristics. A trained sensory panel is better equipped to determine the sensory attributes of a whole product, e.g. OFSP bread.

Trained sensory panel is an assessment method using human subjects with specific abilities to conduct allocated tests. A trained sensory panel is an objective instrument used in providing a descriptive product profile. It has become the standard practice in sensory evaluation (King, Hall and Cliff, 2001). The trained sensory panel can provide information regarding the selected characteristics of products, e.g. bread, in terms of appearance, colour, odour, texture and flavour. It can help in product development, quality control and as a diagnostic instrument to characterise product differences. Trained sensory panels produce product profiles that have a meaning for the industry (King *et al*., 2001). As consumers cannot provide their opinions on complex sensory characteristics for products because the sensory characteristics' used might have a different meaning to consumers, which can interpret the results as problematic (King *et al*., 2001). A trained sensory panel usually consists of 10-12 panellist, which are trained to evaluate food products in a diagnostic manner. Panellist training helps to increase agreement on the descriptive terms used, provides an understanding of the scoring procedure, contributes to panel consistency, aids in establishing uniform rating standards, minimizes the difference in scoring between panellists and helps in distinguishing amongst products (King *et al*., 2001). Even with training, panellists can still differ in their perception of the sensory characteristics. As panellists can attach different meanings to the same characteristic, have different understandings of the intensity, have different capabilities of detecting small differences in the characteristic intensities or panellists can differ in the use of the scale for both ranges of the score and the position of scoring (King *et al*., 2001). Trained sensory panel results are only as good as the performance of the panellists, this is why panellist performance should routinely be examined.

Quantitative descriptive analysis (QDA) is the popular method used for sensory evaluation by a trained sensory panel. QDA uses statistical analysis to determine the appropriate descriptive terms, procedures, and panellists to analyse the bread samples (Meilgaard, Civille, and Carr, 2007b). Panellists are selected for their ability to discriminate differences in sensory properties among samples for which they are to be trained. Training requires the use of the references to generate lexicons for a

product category (descriptive terms) (Table 2.3) (Meilgaard *et al*., 2007b). Here the panel leader acts as a facilitator and does not influence the group. The panellist then re-evaluates the product (e.g. bread) according to the selected lexicon on e.g. a line scale, and the results are statistically analysed. QDA method can respond to all the sensory characteristics of samples, quantitatively determine panellist reliability, have face validity, not be dependent on individual panellists, have a data processing system and be sensibly rapid (Stone, Sidel and Bloomquist, 2008). Careful consideration about the QDA should be taken before conducting QDA in terms of formal instructions, scale scoring by the panellist and constant training with the panellist.

Table 0.3 Examples of lexicons developed for evaluation of a slice of the wheat bread.

Sensory group	Lexicon	Definition	Scale anchors
Appearance	Colour	Intensity of colour	White---Dark
	Pore size	Size of the holes in the crumb	Small---Large
	Pore consistency	Homogeneity of the pores in the crumb	None---High
Aroma	Acetic acid	The sour aroma associated with vinegar	None---High
	Butyric acid	The sour aroma associated with regurgitated milk	None---High
	Lactic acid	The sour aroma associated with soured milk	None---High
	Overall aroma	Overall aroma intensity.	None---High
	Butter	The aroma associated with butter	None----High
	Grain/ wheat	The aroma associated with wheat	None---High
	Toasted	The aroma associated with the caramelized brown flavour of toasted starch such as bread	None---High
	Sweet	The aroma associated with sweet	None---High
	Burnt	The aroma associated with burnt food	None---High
Texture	Surface moistness	Perception of water felt when touching the crumb with a finger	Dry/ not moist ---very moist
	Springiness	The degree to which the crumb returns to its original shape after being compressed by 50%. Compress bread between forefinger and thumb 50%	Does not return to shape---returns quickly to original shape
	Softness	The feeling observed by touching the bread crumb.	Rough---Soft
	Hardness	Force required for the first bite through the sample with the molars	Soft---Hard
	Elasticity	Sample recovery after the first bite	None---High
	Friability/ Fracturability	The ease with which the sample is broken into smaller particles during chewing (crumbly)	None---High
	Graininess	Size of the particles once the sample has been masticated until disintegrated and then formed a homogenous bolus.	None---High
	Doughy	A pasty feeling which is perceived in the mouth during chewing	None---High
	Chewiness	The toughness of the sample perceived during mastication	None---High
	Mouth residue	Amount of residual particles attached to the mouth after chewing	None---High

Table 2.3 Examples of lexicons developed for evaluation of a slice of the wheat bread.

Sensory group	Lexicon	Definition	Scale anchors
	Surface smoothness	The smoothness of the surface evaluated with the tongue after the palette	Smooth---Coarse
Flavour	Sweet	Sweet basic taste	None---High
	Salty	Salty basic taste	None---High
	Sour	Sour basic taste	None---High
	Bitter	Bitter basic taste	None---High
	Pungent	A strong flavour presence	None---High
	Toasted	The flavour associated with the caramelized brown flavour of toasted starch such as bread	None---High
	Oily	The overall flavour of oil	None---High
	Grain/wheat	The flavour associated with grain	None---High
	Aftertaste	Taste experienced after the bread is consumed	None---High

(Gámbaro, Varela and Giménez, 2002; Elía, 2011; Protonotariou, Stergiou, Christaki and Mandala, 2020)

Texture analysis of bread

Texture is an essential multi-dimensional attribute used to assess product quality and acceptability. Bread texture is an important quality indicator because it serves as an indicator of freshness. Bread crumb structure is a very important factor in determining texture. The crumb structure of bread is affected by the chemical, physical and biological changes that occur when the dough is prepared and baked e.g. evaporation of water, the formation of a porous structure, protein denaturation, crust formation and starch gelatinization (Mondal and Datta, 2008).

Texture analyses are usually performed with trained sensory panels, e.g. QDA and imitative instrumental measurement, to obtain correlations between the measurements (Szczesniak, 2002). Imitative instrumental tests mimic the sensory properties conditions as evaluated by humans (Meullenet and Gross, 1999). The food texturometer is a popular objective physical imitative test that can measure various texture attributes for multiple food types. It evaluates the mechanical characteristics of a material when it is subjected to a controlled force .Texture analysers generate texture profiles, which are curves that monitor and record samples' spatial and temporal characteristics during texture measurements, which have been correlated to sensory perception. Texture analysis is an important analytical method for bread evaluation because it can quantify the effects of the dough ingredients on the physical properties of the crust and crumbs of the bread (Szczesniak, 2002; Chen and Opera, 2013).

Texture Profile Analysis (TPA) is a popular imitative test performed using a general food texturometer that was advantageous for generating multiple parameters (Szczesniak, 2002). A mock test performed with a texturometer is more advantageous than using a trained sensory panel (Szczesniak, 2002). The TPA is a two-cycle compression test that produces force/deformation curves that can measure various mechanical parameters of food (Meullenet and Gross, 1999; Chen and Opera, 2013). The double compression test provides a two-bite texture profile curve (Szczesniak, 2002; Chen and Opara, 2013). The characteristic profile of the texture profile analysis

test for a double compression cycle (Figure 2.1) can assess a wide range of food texture properties.

The profile indicates

Hardness: H= maximum force necessary to compress the sample, maximum peak force 1

Springiness: T2/T1= the capacity of the sample to recover to its original form after the compressing force is removed

Cohesiveness: A2/A1= the degree to which the sample could be compressed before rupture

Adhesiveness: A3= the negative area between the first and the second peak

Gumminess: hardness x cohesiveness= the force required to break down a semisolid sample to a state of swallowing

Chewiness: Hardness x springiness x cohesiveness

(Szczesniak, 2002; Gámbaro, Fiszman, Giménez, Varela and Salvador, 2004; Chen and Opera, 2013)

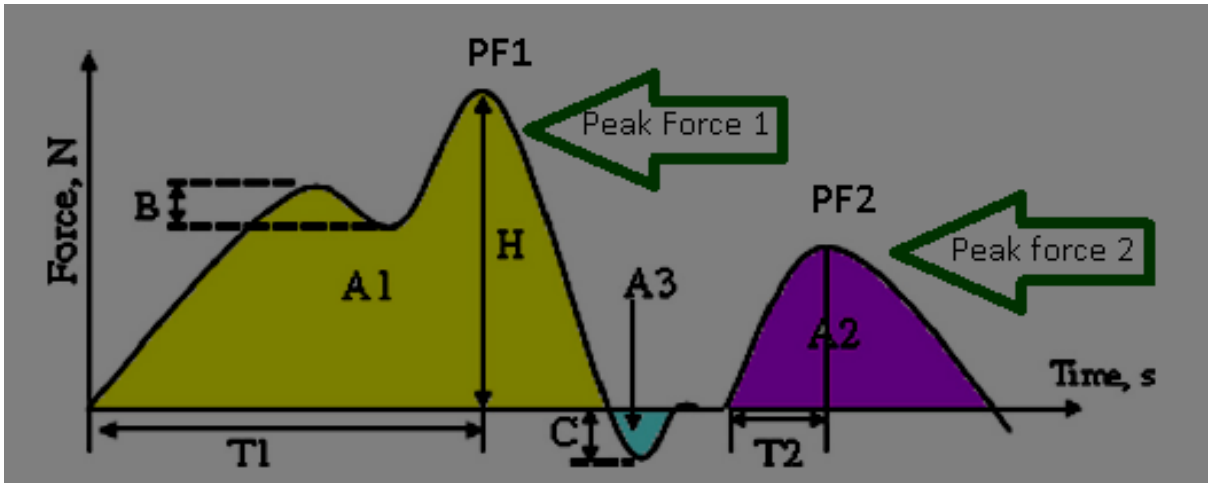


Figure 0.1 Szczesniak mastication profile for texture analysis.

H= Hardness, A3= Adhesiveness, B= Brittleness, C= Cohesion Strength, T1= Indentation, T2= Indentation and A2/A1= Cohesiveness (Chen and Opera, 2013)

The TPA double compression test is the standard test used for characteristic textural evaluation of white pan bread (AACC Method 74-09.01). Crumb refers to the cut surface of the bread when a bread loaf is sliced. The hardness of the bread crumb is mainly due to the interactions between gluten and fibrous materials, and the moisture

content of the bread (Wanjuu, Abong, Mbogo, Heck, Low and Muzhingi, 2018). Bread crumb has a complex rheological structure, as it is comprised of two phases: a fluid and a solid, at a macroscopic level (Korczyk-Szabó and Lacko-Bartošová, 2013). The solid phase is completely connected, with the air cells being isolated. The mechanical properties and structure of the crumb are determined by the volume fraction of the two phases and how they are connected (Korczyk-Szabó and Lacko-Bartošová, 2013). Crumb hardness is related to the moisture content of the crumb (Korczyk-Szabó and Lacko-Bartošová, 2013) with a low maximum force indicating that the bread crumb texture is soft. The high temperatures of the surface of the dough and heat transport to the centre of the dough results in evaporation and condensation causing the water content to rise at the centre of the loaf (Wanjuu,*et al*., 2018). An increase in the water content increases the bread's cohesiveness. Bread with higher cohesiveness is more desirable because less force is required to disintegrate the bread during mastication (Wanjuu,*et al*., 2018), indicating that the bread has a softer texture. Chewiness represents the energy required to chew the bread to a desirable state for swallowing (Wanjuu,*et al*., 2018).

OFSP puree results in a bread with a higher moisture content (Owade *et al*., 2018), because the high water absorption capacity of the OFSP starch is attributed to weak molecular forces between the starch granules. This results in additional molecular surfaces for binding water all through starch gelatinization and finally a higher retained moisture content in the bread (Malavi *et al*., 2022). The higher moisture content in turn should result in a bread that is more cohesive and softer. Owade *et al*. (2018) found that the incorporation of OFSP puree in bread increased the softness of the bread crumb. The increase in the softness of the bread was found to be highly likeable by consumers, as consumers believe soft bread to be fresh (Owade *et al*., 2018).

Colourimeter

Appearance influences consumers' choices and preferences and is an essential sensory quality attribute. Colour is regarded as an essential attribute in selecting a product in terms of appearance because it is the first sensation that the consumers' notice (Pathare, Opara and Al-Said, 2013). The colour of products can be affected by chemical, biochemical, microbial and physical changes. Colour can indirectly correlate

with other quality attributes e.g. flavour, nutritional content, and other non-visual defects (e.g. spoilage) (Pathare *et al*., 2013). Colour is a perceptual sensation. Colour depends on the observer and the conditions under which the product is observed.

Colour development in bread is due to the moisture content of dough, baking time and baking temperature (Mondal and Datta, 2008). The colour of the crust can be attributed to the non-enzymatic chemical reactions: caramelization and Maillard reaction which also contribute to other sensory attributes (Mondal and Datta, 2008). Maillard reaction is a chemical reaction between reducing sugars and free amino acids in proteins which results in the food browning and the development of distinctive flavour molecules (Wanjuu *et al.,* 2018). Caramelization reaction ensues when sugar or carbohydrates are heated to high temperatures resulting in the oxidation of carbohydrates and the development of a brown colour and other sensory attributes (Wanjuu *et al.,* 2018). OFSP puree results in a bread with higher moisture content and thus a thicker browner crust because more water vapour is lost through the vapour pressure gradient (Owade *et al*., 2018).

OFSP contains pigments, e.g. β-carotene, which can impart a yellow or orange colour when used as an ingredient in bread (Pathare *et al*., 2013). The effects of OFSP on colour have not been entirely determined, but previous research has indicated that the OFSP bread has a golden yellow colour (Owade et al., 2018). Most food products have an acceptable colour range, depending on multiple factors. Colours that are not appropriate for a specific product can result in the rejection of the product, as specific food products are associated with a specific colour (Pathare *et al*., 2013). Colour saturation, yellowness and lightness have been found to affect consumer acceptance of white wheat pan bread (Gámbaro *et al*., 2004). The consumers' acceptance of the bread decreased as the colour yellow increased; as measured by instrumental colour analysis and a trained sensory panel (Gámbaro *et al.,* 2004). The colour of OFSP bread can result in the rejection of the bread if the consumers deem the colour to be unacceptable. Owade *et al.* (2018) found that consumers highly liked the golden yellow colour of the OFSP bread in Kenya, but only if the consumers were made aware of the presence of OFSP puree in the bread.

Colour is a characteristic of light, and it is measurable in terms of dominant wavelength λ (nm) and mean reflectancy Ɣ (%). The colour of an object only becomes visible once the light from a luminous object strikes the surface. Different colours selectively absorb light of a visible part of the spectrum when white light shines upon the product (Choudhury, 2014). Parts of the light spectrum are absorbed while others are reflected, creating a particular impression of colour in the human eye (Choudhury, 2014). Colours are characterised by the sum of wavelengths of different intensities, which can be presented as a dominant wavelength. Brightness is a measure of the intensity of colour perception and is an optical quality of colour.

Colour can be described and quantified, with the use of various measuring systems with the most popular system being RGB (red, green and blue), which can be used in colour video monitors, e.g. Hunter *L a b,* Commission International de l'Eclairage (CIE) L^* a^* b^*, CIE LCH, CIE L^* u^* v^*, *CIE XYZ and CIE Yxy* (Granato and Masson, 2010). The systems differ in the colour space proportion and the synchronising system used to define points within the space. The CIE concept is based on the assumption that the human eye has three colour receptors; red, green and blue, and all colours observed are a combination of red, green and blue (Granato and Masson, 2010). The CIE L^* a^* b^* is the most commonly used photoelectronic measurement colour tool, as it provides more uniform colour differences by human perception of colour differences. The CIELAB (L^* a^* b^*) can directly read and measure two colour coordinates, a^* and b^*, and the psychometric index of lightness, L^*. The positive a^* values measure red, and the negative a^* values measure green. The positive b^* measure yellow, and the negative b^* values measure blue. Luminosity, if measured with L^*, measures the colours on a greyscale from white (100) to black (0) (Granato and Masson, 2010).

Colour can be measured using either visual evaluation or instrumental analysis. Visual evaluation requires the colour of the sample to be evaluated with the human sense. The sample are evaluated under controlled conditions, e.g. lighting and colour standards (Pathare *et al*., 2013). The samples colour is observed against defined colour standards under identical lighting. The visual assessment is carried out by trained sensory panels, which produce a detailed description of colour based on particular vocabulary. The trained sensory panel can be provided with colour scales or comparative standards to produce accurate and consistent results.

Perception affects colour. Different people interpret colour differently, making a subjective expression of colour not accurate enough to determine colour. The objective approach to measuring colour is straightforward and exact (Pathare *et al*., 2013). Instrumental measurement produces colour coordinates using an instrument, e.g. colourimeter or spectrophotometer. Colourimeters are the preferred and most common instrument used in colour measurement in the food industry. The colourimeter measures colour with a primary radiation source that emits light and a secondary radiation source that reflects or transmits external light (Pathare *et al*., 2013). Values are optically obtained and not mathematically. The values can differ based on the apparatus used because the colourimeter generates a value of only a standard observer and a standard illuminate. The colourimeter contains three filters that function as the three types of cones in the human eye's retina (Pathare *et al*., 2013). A colourimeter consists of three main components; a source of illumination, a combination of filters to adapt the reflected light's energy dispersal, and a photoelectrical detector to convert reflected light into electrical output (Pathare *et al*., 2013). The measurement obtained by the colourimeter is comparative. Spectrophotometers are used to measure the spectral distribution of transmittance or reflectance of the sample, which is then used to calculate colour under different conditions (Pathare *et al*., 2013). It provides a wavelength-by-wavelength spectral examination of the reflecting and transmitting properties of the product (Pathare *et al*., 2013). Spectrophotometers are not commonly used in the food industry but for scientific research.

Conclusions

Negative attitudes towards food products can hinder the widespread acceptance of new food items and food technologies. The success of new food items and new food technologies thus depends on consumers' behavioural responses. Food neophobia is the fear of trying unfamiliar foods. Food neophobia is measured with the use of FNS. Information regarding food neophobia among consumers in Africa is seriously lacking, with only one study conducted in South Africa.

Vitamin A is an essential vitamin required for immune function, eye and vision health and skeletal growth. Vitamin A deficiency plagues significant parts of Africa, resulting in preventable health conditions. OFSP is a drought-tolerant crop grown in multiple countries in Africa; the tuber is rich in β-carotene. OFSP bread was developed to address vitamin A deficiency, by partially replacing wheat flour with OFSP puree. It is a new type of bread that requires consumer evaluation to determine the acceptance of the bread by the market. Sensory analysis is required to measure the effects that the OFSP puree has on the sensory characteristics of the bread. Food neophobia may play a role in predicting whether the bread will be acceptable to consumers. Gaining more information regarding the acceptability of unfamiliar foods, e.g. OFSP bread, among consumers with different levels of food neophobia could help to understand food choices and preferences. This information can assist in understanding how consumers will react to new nutritional intervention strategies and how these products should be launched to ensure acceptance by the market.

HYPOTHESES AND OBJECTIVES

Hypotheses

Hypothesis 1

Individuals with high food neophobia scores will be less likely to choose unfamiliar food products. Food neophobia is correlated strongly with the likelihood to choose unfamiliar food, as demonstrated in studies by (Tuorila *et al*., 2001; Knaapila *et al*., 2011; Jaeger *et al*., 2017).

Hypothesis 2

High food neophobic individuals will rate bread containing OFSP puree, an unfamiliar ingredient, lower in terms of liking of sensory properties than low food neophobic individuals. High food neophobia individuals give lower hedonic responses and enjoy food and beverage items in general but unfamiliar options, in particular, less compared to food neophilics (Knaapila *et al*., 2011; Siegrist *et al*., 2013; Olabi *et al*., 2015; Jaeger *et al*., 2017; Laureati, Spinelli, Monteleone, Dinnella, Prescott, Cattaneo and Pagliarini, 2018; Spinelli, De Toffoli, Dinnella, Laureati, Pagliarini, Bendini and Monteleone, 2018; Jaeger, Roigard, Le Blond, Hedderley and Giacalone, 2019; Jaeger et al., 2021).

Objectives

Objective 1

To determine the effect of food neophobia on the likelihood to choose food that is unfamiliar/lesser-known. To gain further insight into possible reasons for the acceptance/rejection of unfamiliar food items.

Objective 2

To determine the effects of food neophobia and sensory properties on consumer acceptance of a novel food item, i.e. bread containing OFSP puree. To determine if food neophobia affects the liking of the sensory properties of unfamiliar bread containing OFSP puree, to better establish the possible role food neophobia plays in accepting and rejecting new food items.

MATERIALS AND METHODS

Data was collected in two phases. The first phase involved an online survey to determine the effect of food neophobia on consumers' familiarity with and likelihood to choose a range of nutritionally and sustainability enhanced product concepts, which are less familiar than conventional products (Figure 0.1). The participants were asked how familiar they were with bread, porridge, pasta, biscuits and puffs by asking how often they consume the product on a 5-point scale ranging from 'never' to 'several times a day'. If the participant indicated that they never consume the product then they were excluded from the follow up questions regarding the specific food item. The participant was then subsequently asked how much they like or dislike the particular food item on a 9-point scale ranging from 'dislike extremely' to 'like extremely'. The participant received as short description regarding the unfamiliar food item and was asked to rate how much they expect to like or dislike the unfamiliar food item on a 9-point scale ranging from 'dislike extremely' to 'like extremely'. The participant was asked whether if the price of the familiar food item and unfamiliar food item was the same, how likely they were to choose the specific food item on a 5-point scale ranging from 'very unlikely' to 'very likely'. Each food item was scored one at a time. The participant then completed the alternative food neophobia questionnaire and questions regarding their demographics. The results from the survey was used to divide the participants into three neophobic groups' namely low, medium and high neophobics. The expected liking and willingness to consume the familiar food items compared to the unfamiliar food items for the different food neophobic groups were calculated.

Once the first phase of the study was completed, the second phase commenced. The second phase focused on the sensory properties and consumer acceptance of one of the product concepts, namely bread with OFSP puree as an ingredient (Figure *0.2*). Participants completed the alternative food neophobic questionnai.re and was categorized into low, medium and high neophobic groups. The participants evaluated the wheat and OFSP bread in terms of appearance, colour, texture, mouthfeel, aroma and flavour on a 5-point scale ranging from 'dislike very much' to 'like very much'. Simultaneously a trained sensory panel was conducted on the wheat and OFSP bread in terms of the breads appearance, texture, aroma and flavour. The wheat and OFSP

bread also underwent physical analyses to quantify the texture, colour and appearance of both breads.

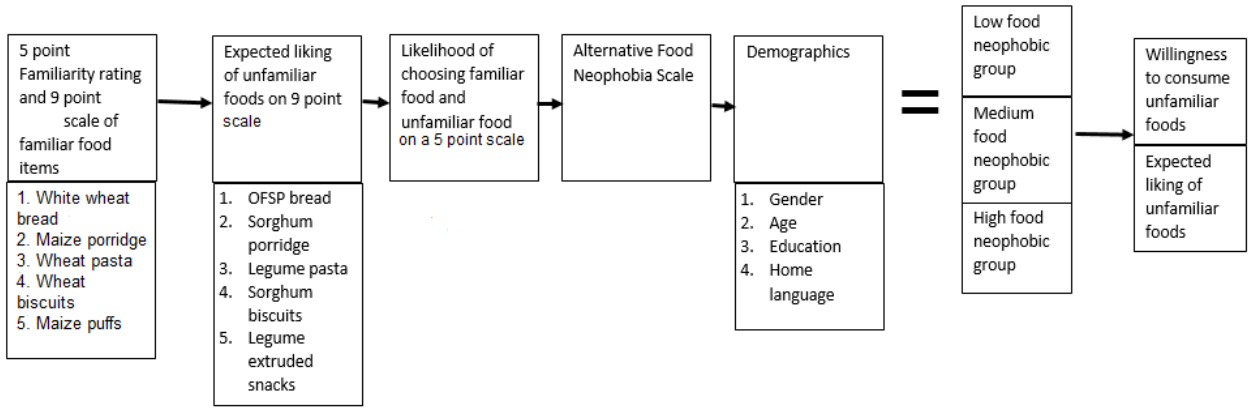


Figure 0.1 Phase 1 of the study

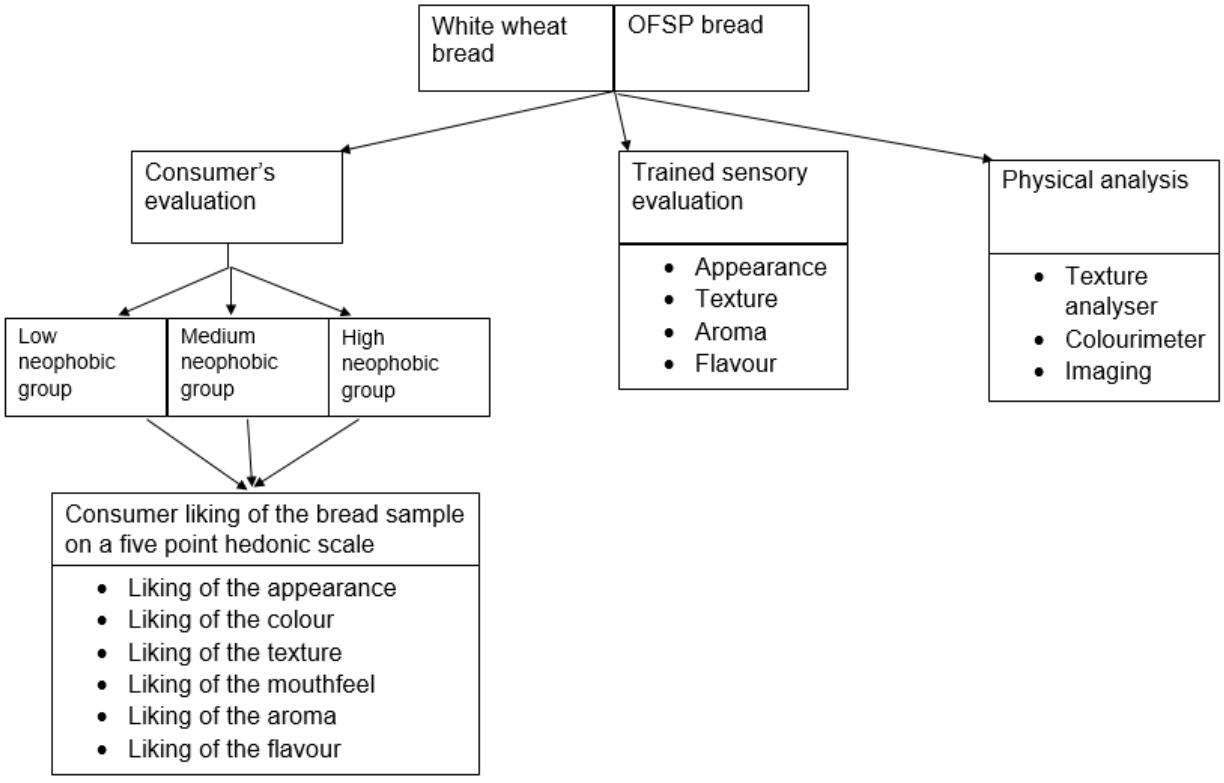


Figure 0.2 Phase 2 of the study

Ethical clearance

The Research Ethics Committee of the Faculty of Natural and Agricultural Sciences approved the study, NAS119/2021.

Phase 1

Participants

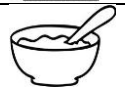
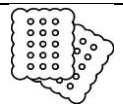
Participants (n=1010; 243 men, 754 women and 13 others, aged from 18 to 71 years, mean=26.5, ±9.0) were recruited from the University of Pretoria consumer database and online social media platforms (e.g., LinkedIn, Facebook and Twitter). Participants in the survey submitted responses using their electronic devices (mobile phones, computers, and tablets). The survey was open over 24 days (27 Jul- 21 Aug 2021). The survey was accessed via an URL link or QR code to Compusense Cloud (https://bit.ly/foodchoiceJul2021). Participants were told that they were filling out a survey on food attitudes and that the survey would help the researchers to understand consumers' attitudes towards selected foods (Appendix 10.1). To generate interest in completing the survey, participants could enter a draw to win a Takealot voucher to the value of R500 if they completed the survey (Appendix 10.2). Only data from participants 18 years and above were collected, and any data received from participants younger than 18 years was disregarded.

Online survey

On recruitment, participants were asked to read information providing background to the study and were made aware that further participation in the survey was considered as providing consent (Appendix 10.2) The survey consisted of three sections; 1) rating familiarity with a range of products (*Table 0.1*), how much you like/expect to like each of the products, and the likelihood of choosing the familiar and unfamiliar products, 2) responding to the statements of an adapted version of the FNS, and 3) completing demographic information.

Ten food descriptions were chosen to represent the familiar and unfamiliar or less familiar/novel foods of plant origin (*Table 0.1*). Participants were shown a black and white clipart depiction of the food items to ensure that participants had a better understanding of the product types (*Table 0.1*).

Table 0.1 Familiar and unfamiliar food items used in the familiarity and likelihood of choosing in the survey

Food type	Clipart provided	Familiar food items	Unfamiliar food items	The benefit of the unfamiliar products
Puffed snacks		Puffed maize snacks	Puffed legume/ bean snacks	Puffed snacks are usually made from maize. Maize is not native to the African continent as it originated in Mexico. Puffed snacks can be made from legume flours, like bean flours. Beans can be gowned sustainably in South Africa. Beans are excellent of dietary fibre, vitamins and minerals.
Porridge		Maize porridge	Sorghum porridge	In South Africa pap/porridge is mainly made from maize. Maize is not native to the African continent as it originated in Mexico. Sorghum (mabele) is a cereal grain native to Africa, a drought-tolerant crop, and sorghum products are a good source of energy and antioxidants.
Biscuits		Wheat biscuits	Sorghum biscuits	Biscuits are usually made from wheat flour. Wheat has to be imported to Africa because the climate is not favourable for wheat production. Biscuits/cookies can be made from sorghum flour. Sorghum (mabele) is a cereal grain native to Africa, a drought-tolerant crop, and sorghum products are a good source of energy and antioxidants.
Pasta		Wheat pasta	Bean/ legume pasta	Pasta is usually made from wheat flour. Wheat has to be imported to Africa because the climate is not favourable for wheat production. Pasta can be made from legume flours, like bean flours. Beans can be gowned sustainably in Africa. Beans are a good source of dietary fibre, vitamins and minerals and do not contain gluten.
Bread		Wheat bread	Orange-fleshed sweet potato bread	Vitamin A deficiency is a significant health issue in South Africa. Vitamin A is an essential nutrient for eye health, vision, immune function, reproduction and fetal development. A new bread has been developed that is naturally high in vitamin A as it contains orange-fleshed sweet potato as an ingredient.

Demographic questions

Participants were asked to provide their year of birth, what gender they identify as (Male, Female or Other), their highest education level completed (1. Primary School, 2. Secondary School, 3. Tertiary education) and their home language (selected from a list of 11 official South African languages and others).

Alternative Food Neophobia Scale (FNS-A)

Participants answered the ten statements (Table *0.2*) of an alternative FNS on a 7-point Likert scale [(1) 'Disagree strongly' and (7) 'Agree strongly']. The presentation order of the statements was randomized. The FNS-A was presented after the questions regarding the five food groups to ensure that participants were not aware of their potential fear of novelty.

Table 0.2 Ten statements of the Alternative Food Neophobia Scale

Item	Statements
1	New food eating experiences are important for me. (R)
2	I am afraid to eat things I have never had before.
3	I don't trust new foods.
4	New foods mean an adventure for me. (R)
5	I like to challenge myself by trying new foods. (R)
6	I am willing to try foods from different cultures. (R)
7	Foods from other cultures look too weird to eat.
8	Foods that look strange scare me.
9	If I do not know what is in a food, I won't try it
10	It is exciting to try new foods when travelling (R)

De Kock, Nkhabutlane, Kobue-Lekalake, Kriek, Steyn, Van Heerden, Purdon, Kruger, Kinnear, Taljaards-Swart and Tuorila, 2022
(R)-Statements for which scoring is reversed

Familiarity and likelihood to choose familiar and unfamiliar versions of everyday food products

Participants rated familiarity with the five familiar food types by answering the question "On average, how often do you consume (the food name)" on a 5-point scale; (1) 'Never', (2) ' 1-4 times a month' (3) ' several times a week' (4) ' daily' and (5) 'Several times a day' (Tuorila *et al*., 2008). If participants indicated that they never consume the specific food product, further questions regarding the food type were skipped.

Participants were asked to rate how much they like or dislike the familiar version of the food type on a 9-point scale from (1) 'Dislike extremely' to (9) 'Like extremely" (Hein, Jaeger, Carr and Delahunty, 2008; Henriques *et al*., 2009).

A short description of the benefits of the unfamiliar/less familiar ingredient/product compared to the ingredient commonly used in the food item followed (*Table 0.1*). Participants were then asked how much they expected to like or dislike the unfamiliar food on the same 9-point scale (1) 'Dislike extremely' and (9) 'Like extremely" (Hein *et al*., 2008; Henriques *et al*., 2009). If participants expected to dislike the product (rating 1 to 4), they were asked to provide a reason/s as to why. Finally, participants were asked what the chance was that they would choose either the familiar or the unfamiliar version if the price were the same on a 5-point scale from (1) 'Very unlikely' to (5) 'Very likely' (Tuorila *et al*., 2001; Schickenberg, van Assema, Brug and de Vries, 2007).

Phase 2

Wheat bread and OFSP bread

Two types of bread were prepared (the formulation is proprietary), wheat bread and bread with partial replacement of the wheat flour and water with OFSP puree (Figure *0.3*). Two batches of each bread type were baked and supplied by a bakery incubator, BICSA, one week apart to serve as experimental replicates. The bread was stored in 230mm x430mm bread bags tied at one end. The bread was stored at room temperature of 23˚C. Room temperature was measured by placing a thermometer next to the bread samples and ensuring that the tip was not covered.

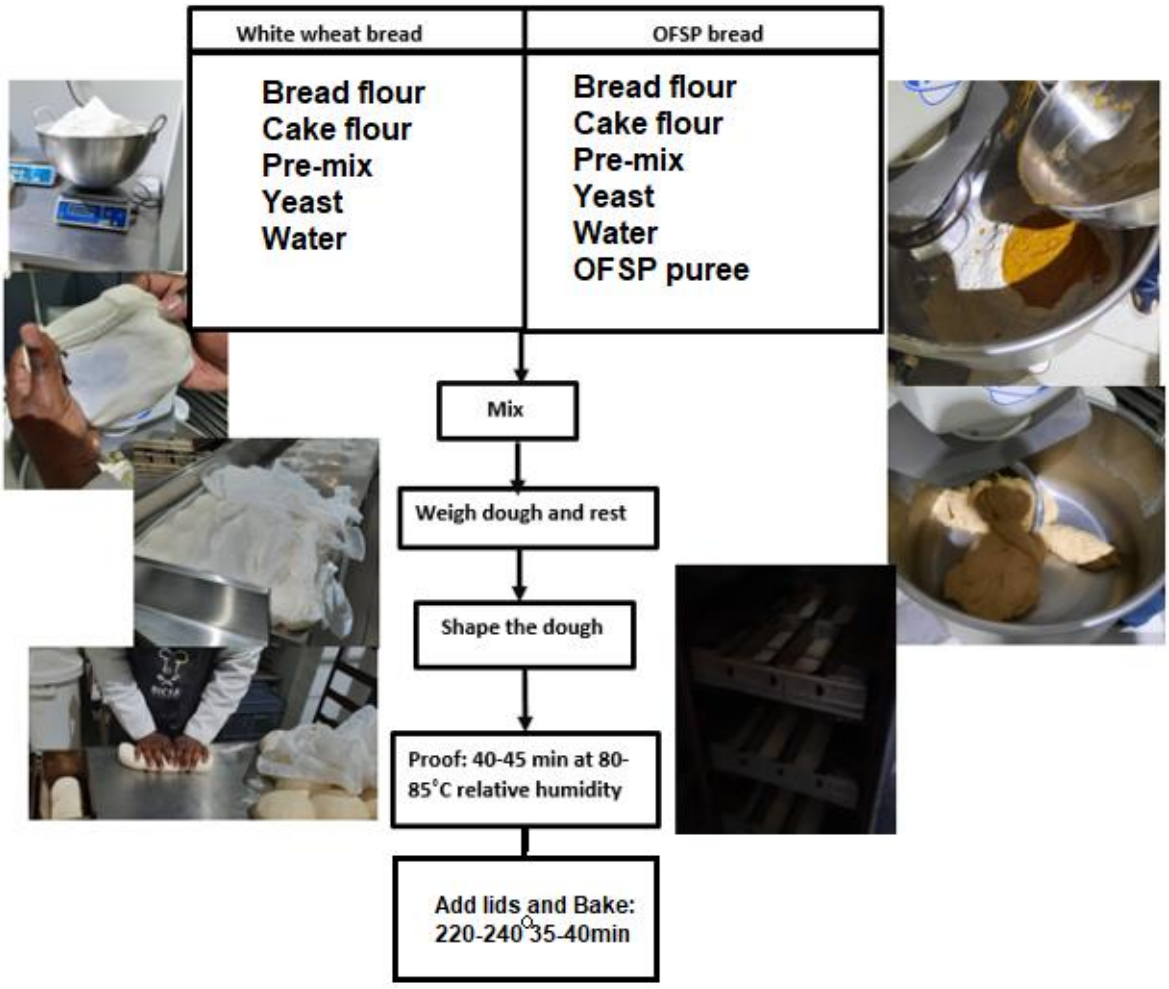


Figure 0.3 Production process for the wheat bread and OFSP bread

Consumer evaluation

Regular consumers of bread were recruited with the help of fieldworkers. The participants (n=82, 26 men and 56 women, aged 19 to 63 years) were students or employees from two companies. Each participant received a R50 Pick ‘n Pay voucher for completing the sensory evaluation survey.

Quarter loaves (6cm) of each bread type (wheat bread and OFSP bread) were placed in 300mm x 450 mm plastic bags. Each consumer received two plastic bags (containing the two bread types) and a pamphlet with the instructions for the evaluation at home (Appendix 10.3). Each bread sample was coded with a random three-digit code, and the order for evaluating the bread samples was balanced across the group.

Consumers were asked to evaluate the bread by completing an online survey (Appendix 10.4). Each consumer had to rate the acceptability of the sensory properties (appearance, texture in hand, aroma, mouthfeel and taste) of the bread samples using a 5-point hedonic scale (1) 'Dislike very much' to (5) 'Like very much' supported by clipart faces to help the panellist decide how much they like or dislike each sample. A frowning face represented 'dislike very much', and a smiley face represented 'like very much'. Consumers were then asked which one of the two bread samples they preferred? The hedonic rating was followed by completing the FNS-A. Participants answered the ten statements (*Table 0.2*) of the FNS-A on a 7-point Likert scale [(1) 'Disagree strongly' and (7) 'Agree strongly']. The presentation order of the scale items was randomized. Consumers were also asked their age, their gender, and to rate how often they consume bread (1) 'Never', (2) '1-4 times a month', (3) 'several times a week', (4) 'daily' and (5) 'Several times a day' (Tuorila *et al*., 2008).

Analytical methods

Descriptive sensory evaluation

Sensory analysis of the wheat and OFSP bread was conducted by 11 experienced panellists (n=11, 3 men, and 8 women). Panellists were remunerated at a set rate per hour of work. For training purposes, panellists were provided with commercial wheat bread purchased from a local store. The panellists individually made a list of descriptive terms for bread evaluation by considering its appearance, aroma, texture, and flavour. The panel leader and the panellists selected the final list of 22 descriptive terms by evaluating the answers and reaching a consensus regarding the descriptors (

Table 0.3).

Table 0.3 Lexicon developed by the trained panellists for wheat bread

	Lexicons	Definition	Scale anchors
Appearance Crumb	Colour intensity	The intensity of the colour of the bread crumb.	Light---Dark
	Brown Speck	The density of brown specks that are present.	None---Many
	Pore/ Air pocket-size	Size of pores/air pockets on the crumb surface.	Small---Large
	Air pocket density	The number of pores/air pockets present on the surface.	Few--Many
Aroma	Overall, Aroma	Overall aroma intensity.	Low---High
	Grain/Wheat	Aroma associated with wheat grains.	None---High
	Fermented sour	Aroma associated with sourness originating from fermentation.	None---High
	Toasted/ Baked	Aroma associated with the caramelized brown aroma of toasted starch such as bread.	None---High
	Butter/ Oily	Aroma associated with butter or fresh oil.	None---High
Texture Crumb	Surface moistness	Perception of water felt when touching the crumb with a finger.	Dry/ not moist---Very moist
	Springiness	The degree to which the crumb returns to its original shape after being compressed 50%. Compress bread between forefinger and thumb 50%.	Does not return to shape---Returns quickly to original shape
	Surface smoothness	The smoothness of the surface, evaluated with the tongue after pressing bread against the palette.	Smooth---Coarse
	Softness	The force required to compress the bread and achieve deformation between teeth with the first bite.	Soft---Firm
	Cohesiveness	The extent to which breadcrumbs stick together during mastication.	Loose/does not stick---Tight/ sticks a lot
	Dissolving in saliva	How rapidly does the bread mass dissolve in saliva during chewing before swallowing.	Dissolves slowly---Dissolves quickly
Flavour Crumb	Flavour intensity	Overall flavour intensity	None---High
	Sour (Fermented)	The flavour associated with sour foods such as vinegar and fermented products	None---High
	Salt	The taste associated with salt	None---High
	Sweet	The taste associated with sugary foods	None---High
	Grain/wheat	The flavour associated with flour or cereal made from wheat	None---High
	Bitter	The taste associated with bitter compounds	None---High
	Toasted	The caramelized brown flavour of toasted starch such as bread	None---High

The trained panel sessions were conducted in the University of Pretoria Sensory evaluation laboratory, where individual cubicles were available for each participant with minimal distraction and influence from other participants (*Figure 0.4*). Each cubicle has a computer providing access to the sensory evaluation task via Compusense Cloud. The evaluation was conducted in English, with a supervisor present. The evaluation sessions were conducted mid-morning to ensure that the panellists were not too full or hungry. The bread was cut with a bread knife. One slice (1.5 cm thickness) of wheat bread and OFSP bread was placed into 150 x 180mm ziplock bags and marked with randomly selected three-digit codes (*Figure 0.4*). The two samples were served on a serving tray alongside brown wheat bread and brown OFSP bread relating to another study, and the serving order was randomised. Each panellist received a glass of water for palate-cleansing and a serviette to wipe their fingers between samples. Panellists were asked to evaluate each bread sample concerning the appearance, smell/ aroma, texture and flavour of the crumb of the bread on an unstructured line-scale anchored at the ends (
Table 0.3). Panellist were asked to not evaluate the outer crust section of the bread slices and only the inner crumb section of the bread slices. Panellists were also provided with the opportunity to give additional comments on the bread samples. The bread samples were evaluated the day after it was baked, and the process was repeated to include a second batch baked one week later. The samples were evaluated under white daylight.

Figure 0.4 Bread samples presentation for trained panellists and cubicles where panellists evaluated the samples

Instrumental colour analyses

A chroma meter CR-400 (Konika Minolta Sensing, Osaka, Japan) was used to measure the L*(100 perfect white, 0 for black), a* (positive values for reddish and negative values for greenish ones) and b*(positive values for yellowish colours and negative values for blueish ones) (Pathare *et al*., 2013). Three random measurements were taken on the crumb of each of three wheat bread and OFSP bread slices. The chroma meter was first calibrated using a white tile before taking any measurement. The chroma (C*) value indicates the colour intensity of the bread samples as perceived by humans. A higher chroma value indicates a stronger intensity of the colour (Pathara *et al*., 2013).

$$C* = \sqrt{(a*^2 + b*^2)}$$

Whiteness indices (WI) indicate the degree of whiteness of a product. It combines lightness, red-green and yellow-blue in a single term (Battle, 1997).

$$WI = 100 - ((100 - L)^2 + (a^2 + b^2))^{½}$$

Instrumental texture analyses

The Shimadzu EZ-L texture analyser (Shimadzu Corporation, Kyoto, Japan) was used to perform the double compression test (Fuchs and Becker, 2018) on the bread using a round flat plastic disk (diameter of 20 mm). Two stacked slices of bread taken from the loaf centre were compressed to 40% of their original height, with a pretest speed of 2.0mm/s test speed of 3 mm/s. A 200N load cell with a resting time of 5s between compressions and a trigger force of 0.05N was applied (AACC Method 74-09.01; Gámbaro *et al*., 2002; Jekle, Fuchs and Becker, 2018). Triplicate measures for the wheat bread and OFSP bread were made. A Vernier calliper was used to measure the height of the two slices of bread from each type. The double compression produces a two-bite texture profile curve with force versus time (*Figure 0.5*). From the curve, the following textural properties can be obtained: hardness/ firmness (Peak Force 1) and resilience ((Peak Force 2)/ Peak Force 1)* 100). Gámbaro *et al*., 2002; Chen and Opera, 2013; Jekle *et al*., 2018).

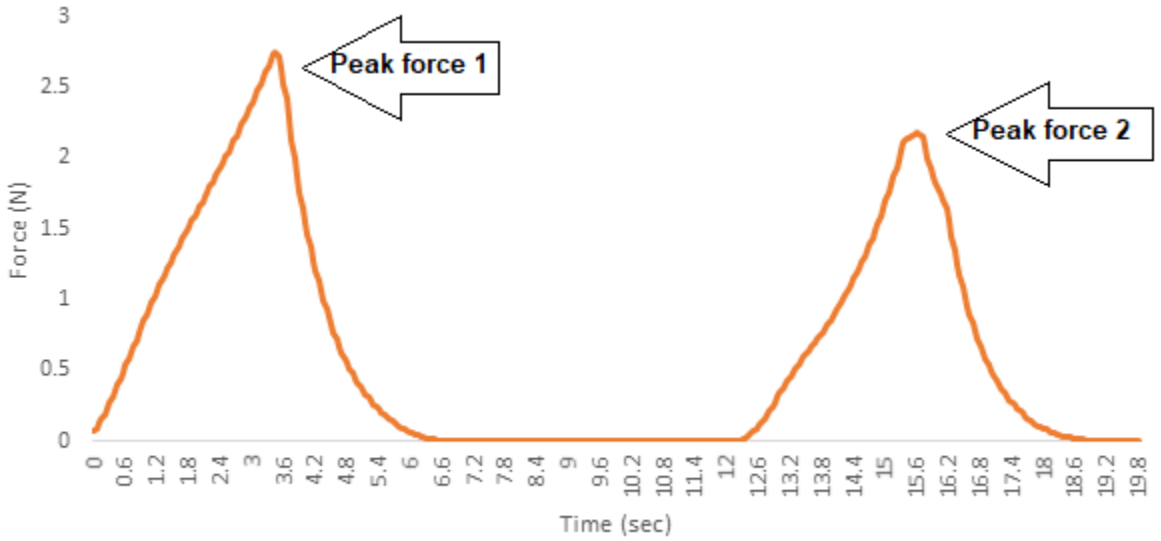


Figure 0.5 Expected plot by the texture analyser for bread indicating the peak force one and peak force two

Imaging of the bread

A slice of bread from the middle of a loaf and outer ends of different bread types were scanned using a Samsung A51 camera (megapixel 48) in actual colour at a resolution

of 3000x4000 DPI. Rulers were placed next to each bread sample for scale. The scanned images produced were saved in JPEG format.

Data analyses

Descriptive statistics

The scores for the five positive statements (1, 4, 5, 6, and 10) were reversed (1→7, 2→6, 3→5, 4→4, 3→5, 2→6, and 7→1). Individual FNS-A scores were computed as the sum of the ratings given to the ten statements, resulting in the FNS-A scores ranging from 10 to 70. The arithmetic means median and standard deviation were calculated. Food neophobic groups were determined using the mean scores and standard deviation, according to Tuorila *et al.,* 2001; Ritchey *et al.,* 2003; Henriques *et al.*, 2009; Meiselman *et al.*, 2010; Jaeger *et al.*, 2021. Thus the participants were divided into three food neophobia subgroups; low, medium, and high, based on the FNS-A score.

Low neophobic > (mean - standard deviation),

(Mean - standard deviation) ≤ Medium neophobic ≥ (mean + standard deviation) and

(mean+ standard deviation) < High neophobic

(Tuorila *et al*., 2001).

Phase 1

Internal consistency of FNS-A was measured using Cronbach's alpha, the coefficient of reliability of the scale.

Exploratory factor analysis (EFA) (maximum likelihood) was performed on the 10-items statements. The results were then rotated using direct oblimen rotation, with delta at zero. The rotation was selected because of the relatively high correlations among the factors.

The correlations (Pearson's r) between FNS-A scores and liking of the familiar versions of the food types, expected like of the less familiar versions and expected likelihood of choosing the foods were computed at a 5% significance level. One-way analysis of variance (ANOVA) was used to determine the effect of the food neophobia groups on

the liking and expected liking of and the likelihood of choosing familiar and unfamiliar food products at a 5% significance. Where significant, the pairwise Tukey post hoc test was applied to separate means.

Phase 2

The participants were divided into three food neophobic subgroups, as explained in descriptive statistics 4.3.5.1.

Internal consistency of the FNS-A scale was measured as explained in phase 1 4.3.5.2.

The correlations between FNS-A scores and liking of the appearance, colour, aroma, texture, mouthfeel, and flavour of wheat bread and OFSP bread were computed with Pearson's coefficients at a 5% significance level (Meilgaard, Civille, and Carr, 2007a). ANOVA was performed to determine the effect of food neophobia groups on the liking of the sensory properties of wheat bread and the OFSP bread. ANOVA was performed to determine the effect of the bread type on the sensory properties, colour, and instrumental texture properties. Where significant, the pairwise Tukey post hoc test was applied to separate means. Statistics were carried out with IBM SPSS Statistics 27 (SPSS Inc., IL., USA).

RESULTS

Phase 1

Table *0.1* shows the mean values and standard deviations used to classify the participants into three neophobic groups. 1010 consumers participated, with 174 identified as low neophobic, 664 medium neophobic, and 172 high neophobic (*Table 0.1*).

Table 0.1 Food neophobic groups* and the overall mean for the online survey

	Range	N	%
Low	10-18	174	17.23
Medium	19-40	664	65.74
High	41-70	172	17.03
Mean	29.09 (±10.71)	1010	

* (Tuorila *et al*., 2001)

(±) indicates standard deviation

Mainly females (75%) took part in phase 1 (Table *0.2*). The majority of the participants were between 18 and 25 years. The participants either had an education at the secondary or tertiary level. The home language was diverse among the participants, most speaking English, Afrikaans, or Sepedi.

Table 0.2 Demographic representation of the participants by gender, age, education, and home language

Variable	Categories	%
Gender		
	Female	75
	Male	24
	Other	1
Age (years)		
	18-25	67
	26-35	22
	36-45	4
	46-55	4
	56<	3
Education		
	Secondary	45
	Tertiary	55

Table 5.2 Demographic representation of the participants by gender, age, education, and home language

Variable	Categories	%
Home language		
	English	25
	Afrikaans	17
	Sepedi	12
	Sesotho	4
	Tswana	10
	siSwati	2
	Tshivenda	3
	Xitsonga	4
	isiNdebele	2
	isiXhoso	5
	isiZulu	11
	Other	4

The Cronbach alpha was 0.86 for the FNS-A. The removal of any question did not result in a significant change in the Cronbach alpha score. A Cronbach alpha score exceeding the 0.7 threshold is satisfactory when measuring internal consistency (Tavakol and Dennick, 2011).

The ten statement FNS-A was divided into two factors based on exploratory factor analysis (EFA) (*Table 0.3*) to determine the underlying relationships between the measured variables. Factor 1 shows its effect on the ten statements while controlling factor 2. Factor 2 shows its effect on the ten statements while controlling factor 1. Statements 1, 4, 5, 6, and 10 loaded onto factor 1, and statements 2, 3, 7, 8, and 9 loaded on factor 2.

Table 0.3 Factor loadings of the exploratory factor analysis (EFA) of the ten statement FNS-A solution (n=1010)

Item	Statements	Factor 1	Factor 2
1	New food eating experiences are important for me. (R)	**0.809**	0.002
2	I am afraid to eat things I have never had before.	0.066	**0.771**
3	I don't trust new foods.	0.070	**0.702**
4	New foods mean an adventure for me. (R)	**0.829**	-0.003
5	I like to challenge myself by trying new foods. (R)	**0.775**	0.036
6	I am willing to try foods from different cultures. (R)	**0.614**	0.139
7	Foods from other cultures look too weird to eat.	0.047	**0.528**
8	Foods that look strange scare me.	-0.84	**0.723**
9	If I do not know what is in a food I won't try it.	-0.008	**0.467**
10	It is exciting to try new foods when travelling (R)	**0.755**	-0.069
	% Variance	43.5	8.4

Items negative to neophobia a marked with R, scores reversed.
Bold numbers indicate if the statement correlates with the factor.

Table 0.4 shows the correlations between FNS-A score and liking/expected liking and the likelihood of choosing familiar and unfamiliar products. There was a statistically significant correlation between FNS-A scores and the 'expected liking' and the 'likelihood of choosing' the unfamiliar products; OFSP bread, sorghum porridge, legume/bean pasta, sorghum biscuits, and puffed legume/bean snacks (P<0.001). There was a significant correlation between the FNS-A score and the 'liking' and the 'likelihood of choosing' the more familiar food items. The correlations between the FNS-A scores and the 'liking/expected liking' and the 'likelihood of choosing' were stronger for unfamiliar products than familiar ones.

Table 0.4 Pearson correlation values (r) for FNS-A score and liking/expected liking and likelihood of choosing the familiar and unfamiliar products

Food name		**Liking/expected liking**		**Likelihood to choose**	
		Familiar food product	Unfamiliar food product	Familiar food product	Unfamiliar food product
Bread	Wheat	-0.018$^{n.s.}$		-0.079*	
	OFSP		-0.265**		-0.251**
Porridge	Maize	-0.008$^{n.s.}$		-0.037$^{n.s.}$	
	Sorghum		-0.166**		-0.130**
Pasta	Wheat	-0.106**		-0.039$^{n.s.}$	
	Bean/ legume		-0.197**		-0.236**
Biscuits	Wheat	-0.097**		-0.026$^{n.s.}$	
	Sorghum		-0.141**		-0.159**
Puffed snacks	Maize	-0.033$^{n.s.}$		-0.016$^{n.s.}$	
	Bean/ legume		-0.184**		-0.167**

n.s.- Not significant **.P<0.001 (2-tailed)
*.P< 0.05 (2-tailed)

There was a significant difference between liking familiar and expected liking of unfamiliar foods, with the liking of familiar products always being more positive (p<0.05) (*Figure 0.1*).

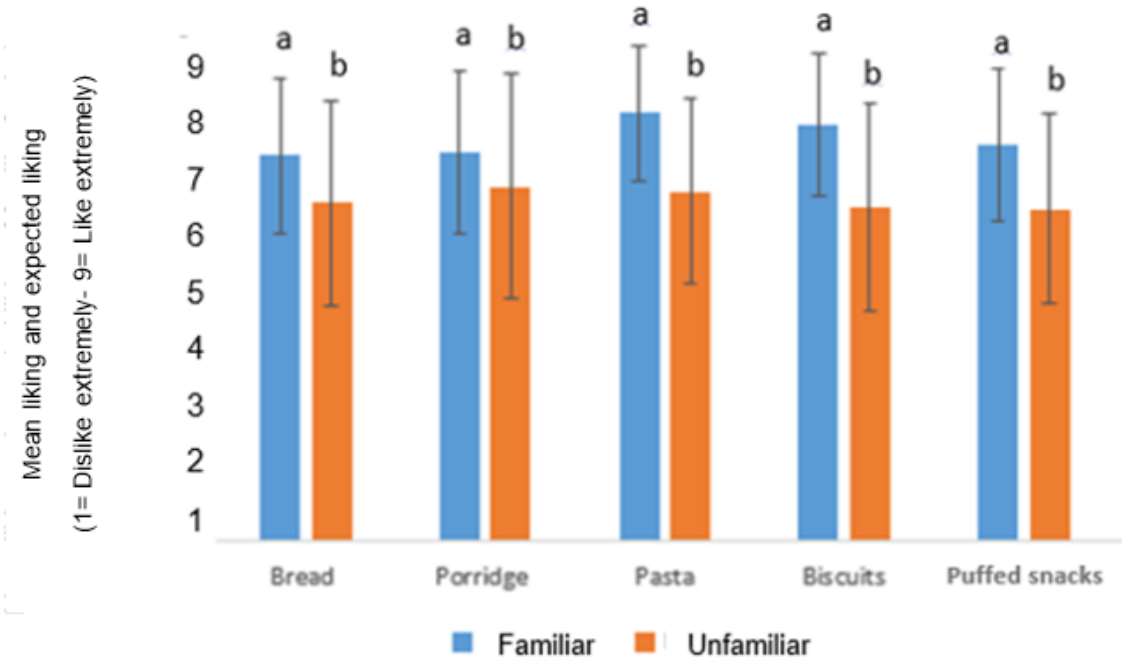


Figure 0.1 Comparison of the mean liking of familiar and expected liking of the unfamiliar food items. Error bars indicate the standard deviation. Products within the same food group with different letters are significantly different ($p<0.05$)

The unfamiliar items followed the same trend where the 'expected liking' for the product decreases as the food neophobia increases from low to high (*Figure 0.2*). For the familiar food items and sorghum porridge, no differences between the likings of the products by the food neophobic groups were noted (*Figure 0.2*).

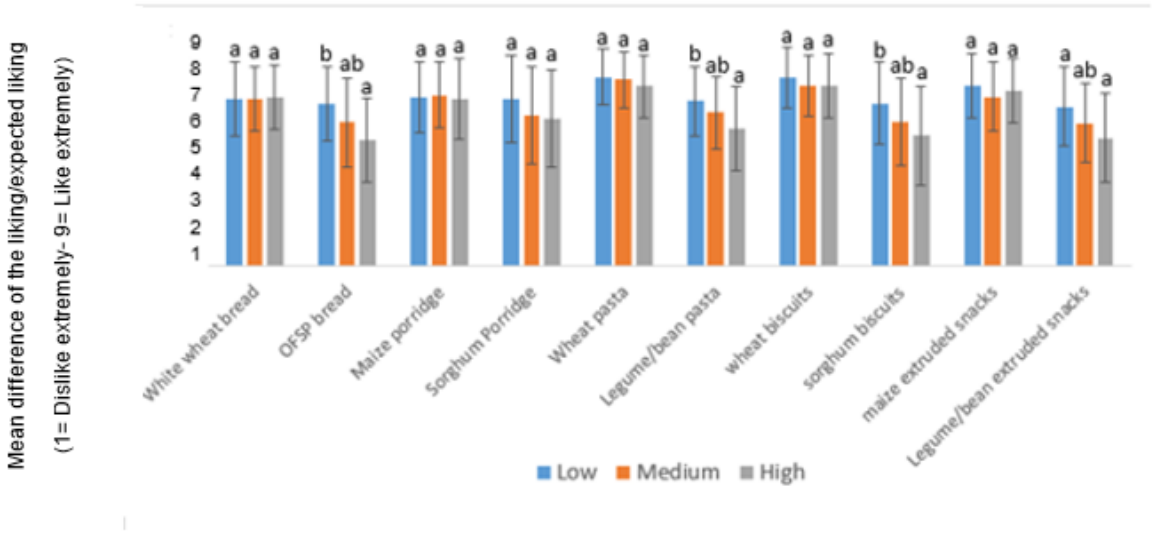


Figure 0.2 Difference in mean liking and expected liking for the low, medium and high food neophobic groups for the familiar and unfamiliar foods. Error bars indicate the standard deviation. Products within the same food group with different letters are significantly different ($p<0.05$)

The difference between 'liking' of the familiar food and 'expected liking' of the unfamiliar food increased as food neophobia increased (*Figure 0.3*).

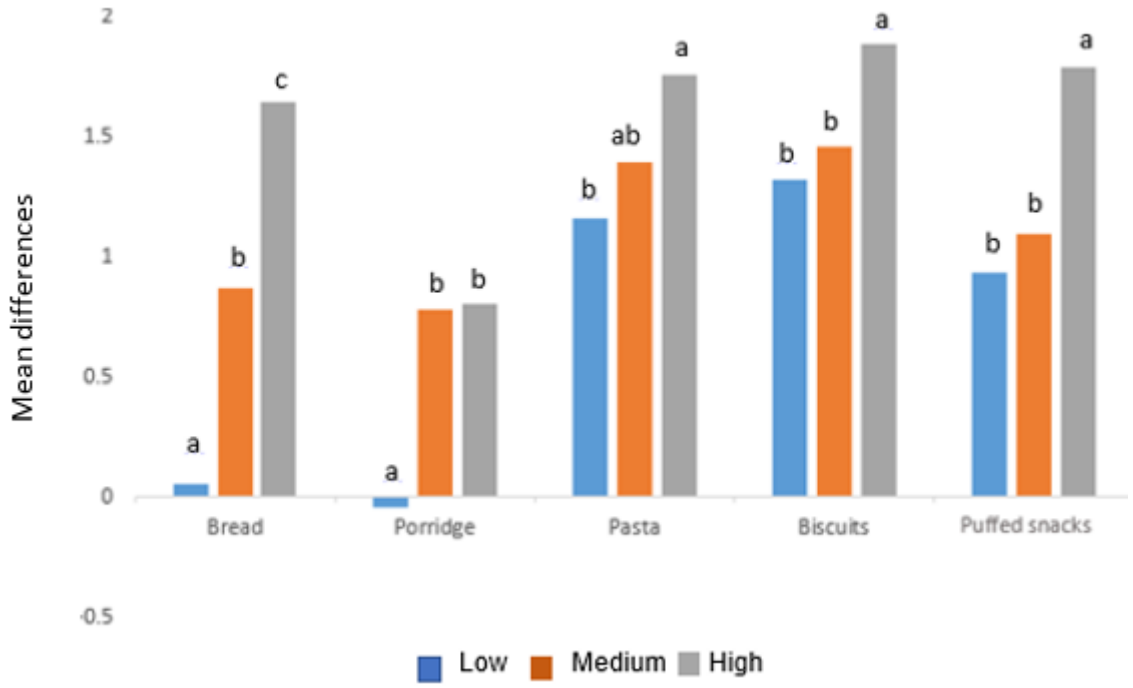


Figure 0.3 Mean differences for the familiar and unfamiliar food items in terms of liking and expected liking in the different food neophobic groups. Products within the same food group with different letters are significantly different ($p<0.05$)

There was a significant difference between the likelihood of choosing familiar and unfamiliar foods (*Figure 0.4*). The five familiar food items were more likely to be selected than the five unfamiliar food items.

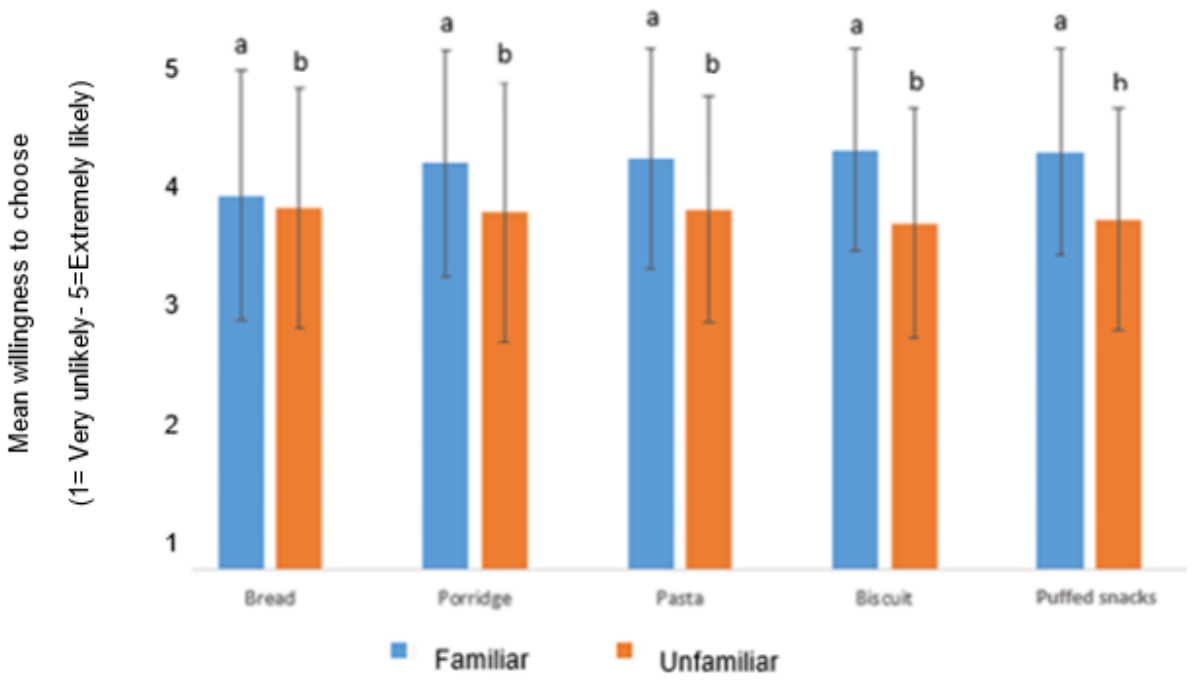


Figure 0.4 Expected willingness to choose the familiar and unfamiliar food items. Error bars indicate the standard deviation. Products within the same food group with different letters are significantly different ($p<0.05$)

The 'likelihood of choosing' an unfamiliar food item decreases as food neophobia increased (*Figure 0.5*). There was no difference in the likelihood of choosing familiar food items between the three food neophobic groups.

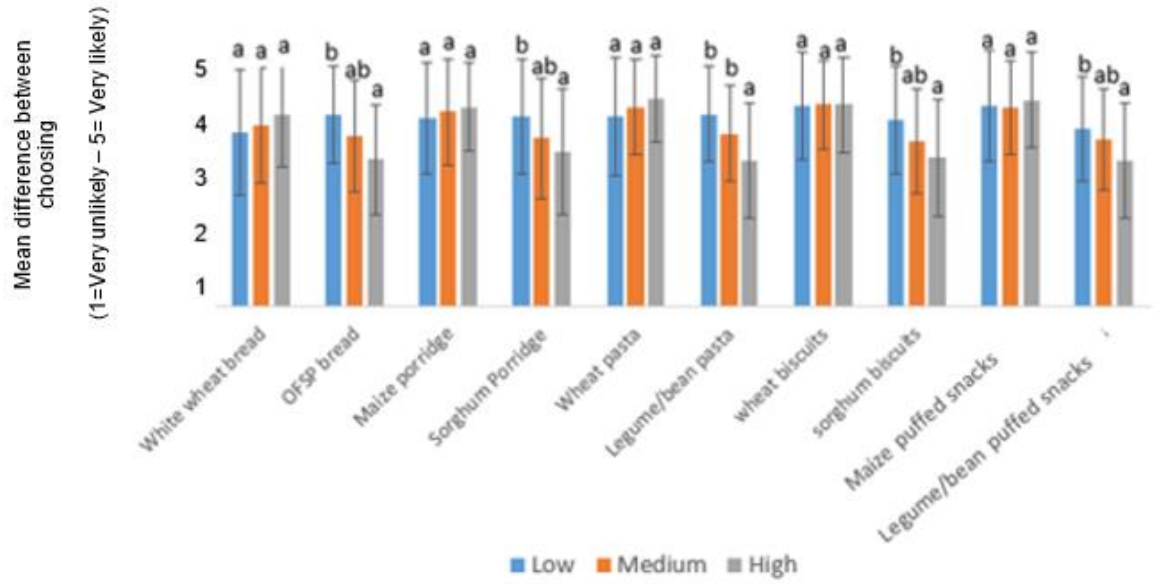


Figure 0.5 Willingness to choose familiar and unfamiliar foods by different food neophobic groups. Error bars indicate the standard deviation. Products within the same food group with different letters are significantly different ($p<0.05$)

The differences between the 'likelihood to choose'familiar food and unfamiliar food increased as food neophobia increased (Figure *0.6*). The differences in the likelihood of choosing between the familiar and unfamiliar products were significant between the three groups for the bread and pasta food categories.

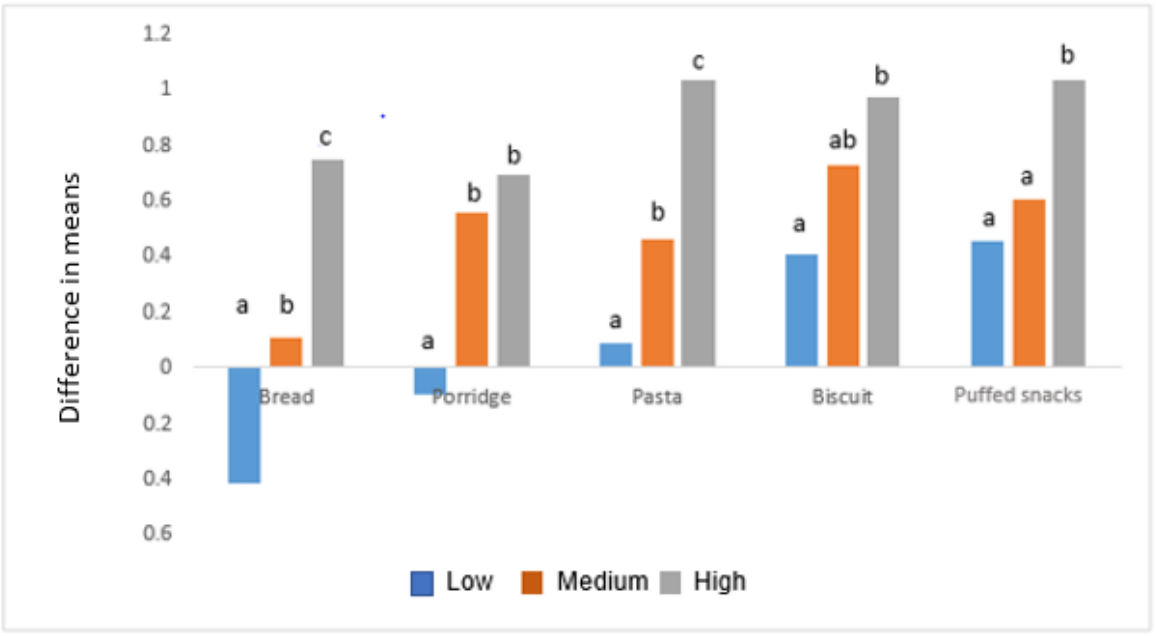


Figure 0.6 Mean differences for the familiar and unfamiliar food items in terms of the expected willingness to choose the familiar and unfamiliar foods categorized by the different food neophobic groups. Products within the same food group with different letters are significantly different ($p<0.05$)

Phase 2

Eighty-two (82) consumers participated, with 16 identified as low neophobic, 52 medium neophobic and 14 high neophobic (Table 0.5).

Table 0.5 Consumers divided into their food neophobic groups

	Range	**N**	**%**
Low	10-17	16	20
Medium	18-38	52	63
High	29-70	14	17
Mean (±standard deviation)	27.30 (±10.21)	82	

Table 0.6 shows that 67% of the participants were female, and 46% were 18 to 25 years old.

Table 0.6 Demographic representation of the participants in terms of gender and age

Variable	Categories	%
Gender		
	Female	67
	Male	33
Age (years)		
	18-25	46
	26-35	27
	36-45	16
	46-55	7
	56<	4

The Cronbach alpha score for the FNS-A survey for the group of consumers was 0.79.

Table 5.7 shows that there was no significant correlation between the FNS-A scores and liking of the sensory properties of familiar wheat bread or unfamiliar OFSP bread.

Table 0.7 Pearson correlation values (r) between the FNS-A scores and liking of the appearance, colour, aroma, texture, mouthfeel and flavour of the wheat and OFSP bread

	Wheat bread	OFSP bread
Liking of the appearance	$-0.039^{n.s.}$	$-0.186^{n.s.}$
Liking of the colour	$-0.470^{n.s.}$	$-0.149^{n.s.}$
Liking of the aroma	$-0.002^{n.s.}$	$-0.051^{n.s.}$
Liking of the texture	$-0.104^{n.s.}$	$-0.029^{n.s.}$
Liking of the mouthfeel	$-0.167^{n.s.}$	$-0.081^{n.s.}$
Liking of the flavour	$-0.050^{n.s.}$	$-0.193^{n.s.}$

OFSP- Orange-fleshed sweet potato n.s. Not significant

There was no significant difference between how much all the consumers liked the sensory properties of the wheat bread and OFSP bread (Figure 0.7), except for colour.

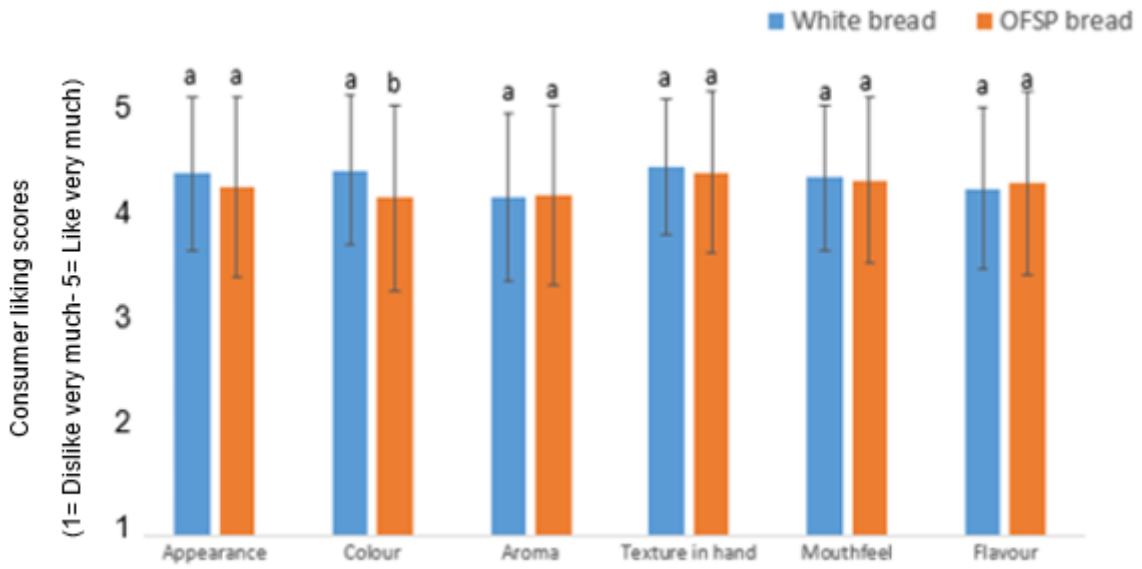


Figure 0.7 Consumer liking of the appearance, colour, aroma, texture in hand, mouthfeel and flavour of the wheat and the OFSP bread. Error bars indicate the standard deviation. Columns with a different letter differ significantly ($p<0.05$)

There was no significant difference between the liking of the sensory properties of the wheat bread by the food neophobic groups (*Table 0.8*).

Table 0.8 Consumer liking (1= Dislike very much- 5= Like very much) of the appearance, colour, texture, mouthfeel, aroma and flavour of the wheat bread for each FNS-A group.

	Low neophobic	**Medium neophobic**	**High neophobic**
Liking of the appearance	4.44^{a} (±0.73)	4.10^{a} (±0.98)	4.36^{a} (±0.63)
Liking of the colour	4.25^{a} (±0.86)	4.33^{a} (±0.88)	3.93^{a} (±0.83)
Liking of the texture	4.56^{a} (±0.63)	4.19^{a} (±0.86)	4.36^{a} (±0.63)
Liking of the mouthfeel	4.50^{a} (±0.82)	4.08^{a} (±0.90)	4.07^{a} (±0.62)
Liking of the aroma	3.94^{a} (±1.00)	3.90^{a} (±1.03)	4.07^{a} (±0.73)
Liking of the flavour	4.13^{a} (±1.09)	4.02^{a} (±0.96)	4.00^{a} (±0.78)

Mean values with different letters in a column differ significantly at $p<0.05$; the standard deviation is given in parentheses.

There was no significant difference between the liking of the sensory properties of the OFSP bread by the food neophobic groups (*Table 0.9*).

Table 0.9 Consumer liking (1= Dislike very much 5= Like very much) of the appearance, colour, texture, mouthfeel, aroma and flavour of the OFSP bread for each FNS-A group.

	Low neophobic	Medium neophobic	High neophobic
Liking of the appearance	4.25^{a} (±0.68)	4.06^{a} (±1.10)	3.09^{a} (±1.35)
Liking of the colour	4.19^{a} (±0.83)	3.87^{a} (±1.07)	3.86^{a} (±1.41)
Liking of the texture	4.38^{a} (±0.81)	4.13^{a} (±0.99)	4.36^{a} (±0.93)
Liking of the mouthfeel	4.25^{a} (±0.93)	4.11^{a} (±0.96)	4.07^{a} (±1.07)
Liking of the aroma	4.00^{a} (±1.10)	3.88^{a} (±1.11)	4.21^{a} (±0.70)
Liking of the flavour	4.13^{a} (±0.89)	4.17^{a} (±0.96)	3.79^{a} (±1.58)

Mean values with different letters in a column differ significantly at $p<0.05$; the standard deviation is given in parentheses.

Appearance of the wheat bread compared to the OFSP bread

The trained sensory panel found no significant difference in the number of brown specks, air pocket size and air pocket density between the wheat bread and the OFSP bread (Figure 0.8). The wheat bread and OFSP bread were significantly different in cream colour.

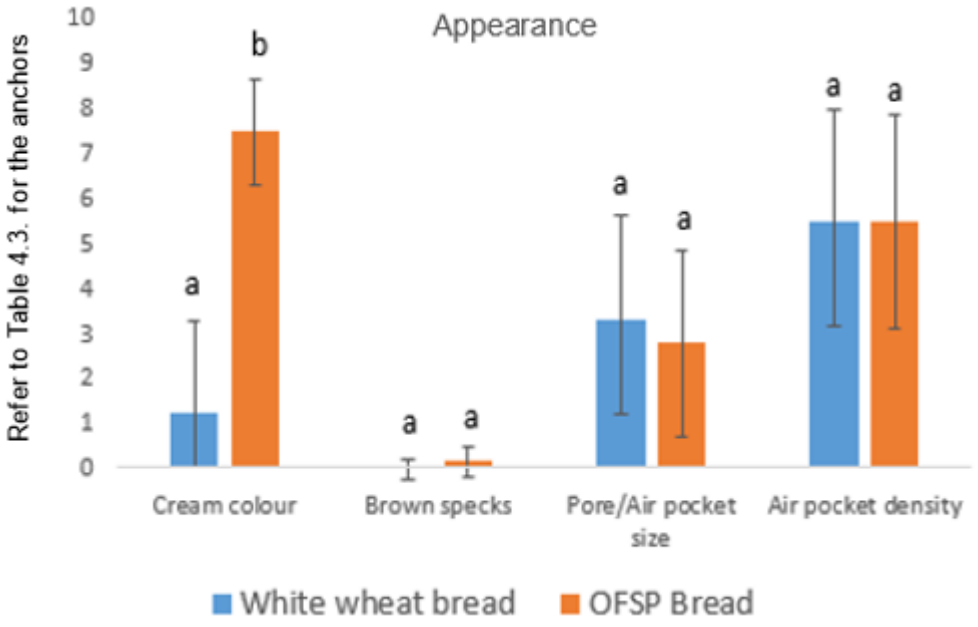


Figure 0.8 Appearance properties of the wheat bread and OFSP bread as determined by the trained sensory panel. Error bars indicate standard deviation. For each descriptor, means with different letters are significantly different ($p<0.05$)

The wheat bread and OFSP bread differed significantly in chroma values (*Table 0.10*). The wheat bread and OFSP bread differed significantly in whiteness indices. The wheat bread and OFSP bread differed significantly in terms of the L* and b* values.

Table 0.10 *L*, a*, b*,* chroma value and whiteness indices of the wheat bread and the OFSP bread as performed by a colourimeter

	L*	***a****	***b****	**Chroma value**	**W (Whiteness Indices)**
Wheat bread	80.16[a] (±10.85)	-0.59[a] (±0.22)	11.86[a] (±1.74)	11.87[a] (±1.74)	75.21[a] (±6.00)
OFSP bread	72.93[b] (±9.80)	-0.22[a] (±0.25)	22.97[b] (±1.9)	22.97[b] (±1.90)	63.53[b] (±5.10)

Mean values with different letters in a column differ significantly at p<0.05.
The standard deviation is given in parentheses.

The physical dissimilarities can be seen in Figure *0.9* & Figure *0.10*. The colour difference between the wheat bread and OFSP bread can be seen in (Figure *0.9*). The wheat bread is larger than the OFSP bread (*Figure 0.10*).

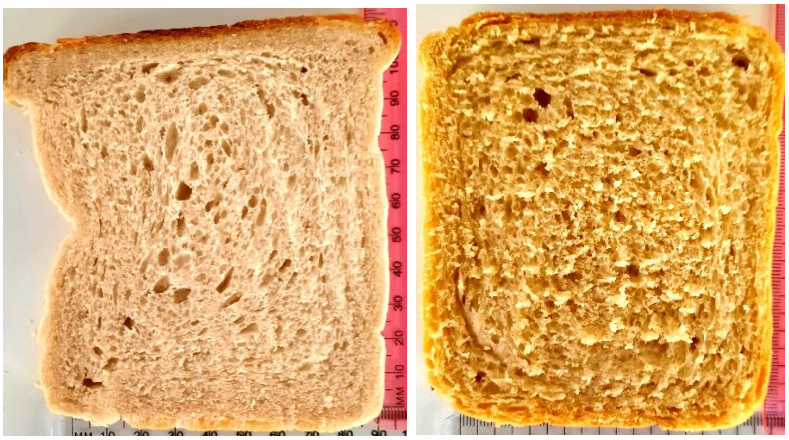


Figure 0.9 Slice of the wheat bread (left) and OFSP bread (right)

Figure 0.10 Side end of wheat bread (left) and OFSP bread (right)

Aroma of the wheat bread compared to the OFSP bread

The trained sensory panel found no significant difference in the overall aroma intensity, grain/wheat aroma, fermented/sour aroma, toasted/baked aroma and butter/oily aroma between the wheat bread and the OFSP bread (Figure *0.11*).

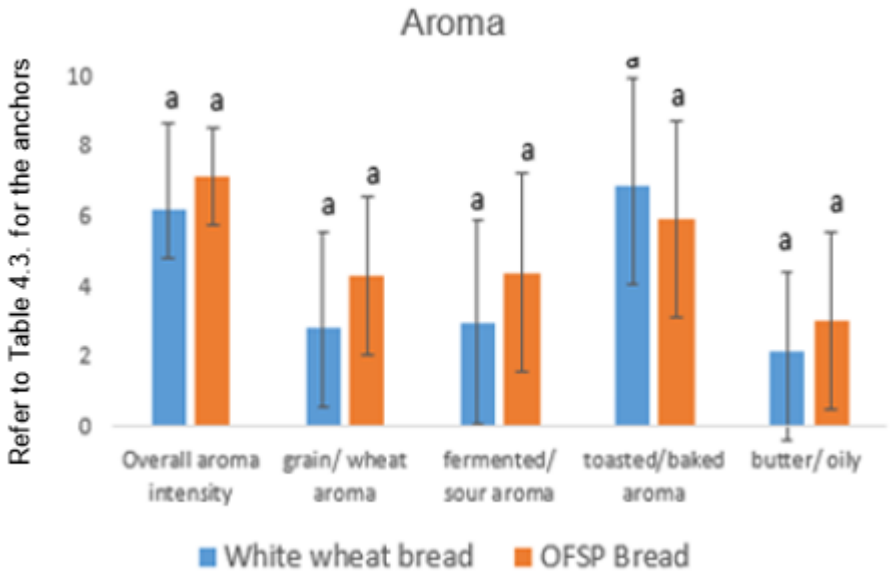


Figure 0.11 Means for the aroma properties for the wheat bread and OFSP bread, as determined by the sensory panel. Error bars indicate standard deviation. Descriptors with different letters are significantly different ($p<0.05$)

Texture of the wheat bread compared to the OFSP bread

The trained sensory panel found no significant difference in the surface moistness, springiness, surface smoothness, softness, cohesiveness and rate of crumb dissolving in saliva between the wheat bread and the OFSP bread (*Figure 0.12*).

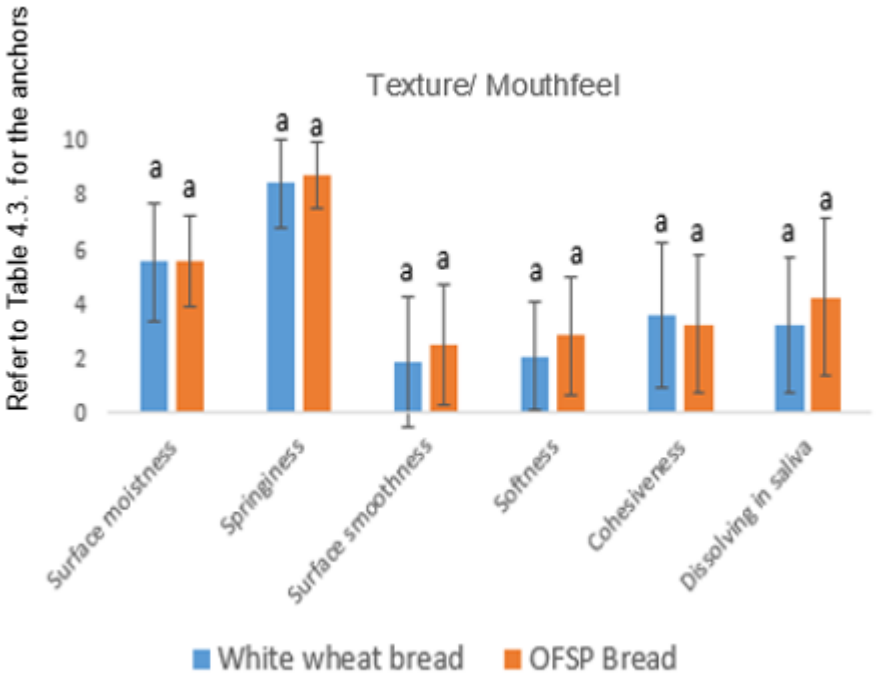


Figure 0.12: Texture and mouthfeel properties for the wheat bread and OFSP bread, as determined by the trained sensory panel. Error bars indicate standard deviation.

The texture analyser showed that there was no significant difference between the wheat bread and OFSP bread for peak force one and peak force two (Table *0.11*). There was no significant difference in the percentage resilience between the wheat bread and the OFSP bread.

Table 0.11 Peak force 1, peak force 2 and percentage resilience for wheat bread and OFSP bread

	Wheat bread	**OFSP bread**
Peak force 1 (N)/ Firmness	2.38^{a} (±1.04)	2.99^{a} (± 0.83)
Peak force 2 (N)	2.23^{a} (±1.03)	2.76^{a} (± 0.7)
Resilience (%)	92.72^{a} (± 2.17)	92.74^{a} (± 2.42)

Mean values with different letters in a row differ significantly at $p<0.05$; the standard deviation is given in parentheses.

Flavour of the wheat bread compared to the OFSP bread

According to the trained sensory panel, the overall flavour and sour taste were significantly different between the wheat bread and the OFSP bread (*Figure 0.13*). There were no significant differences in the salt, sweet, bitter taste, grain/wheat, and toasted aroma between the wheat and OFSP bread.

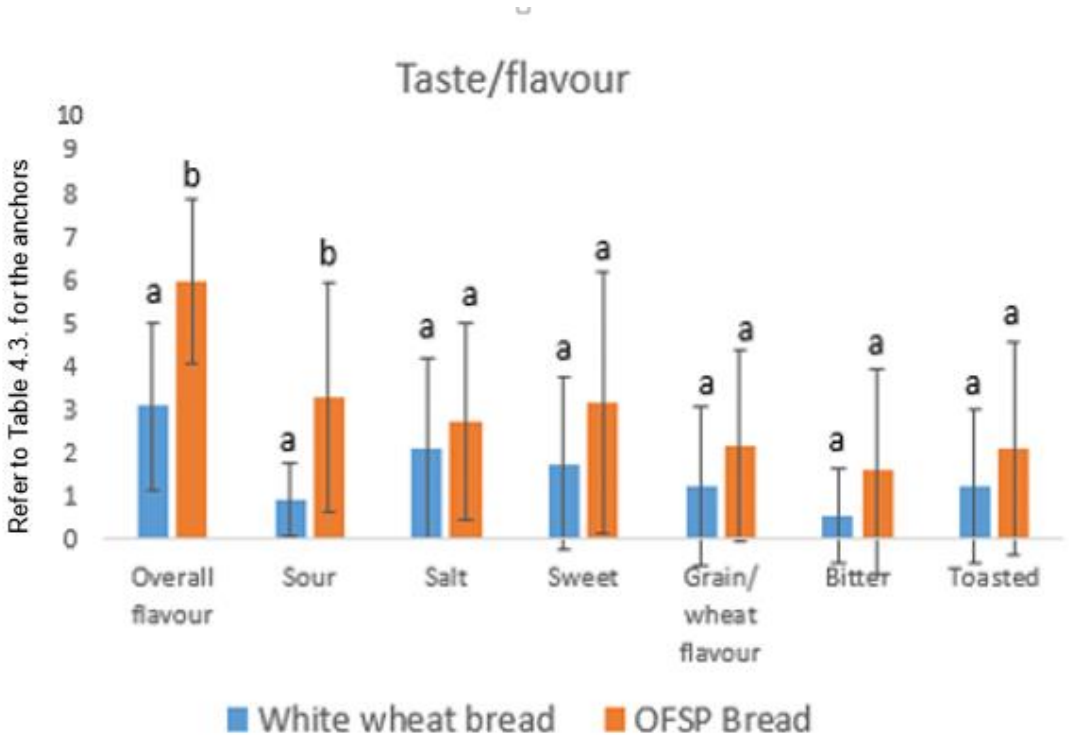


Figure 0.13 Means for the taste properties of the wheat bread and OFSP bread, as determined by the sensory panel. Error bars indicate standard deviation. Descriptors with different letters are significantly different ($p<0.05$)

DISCUSSION

Phase 1

The majority of the participants were medium food neophobic (n=664) (Table *0.1*), with the number of low (n= 174) and high (n=172) neophobic individuals being almost the same. A mean FNS score of 29 was recorded. Very similar FNS mean scores were found in studies conducted in the UK (30) (Choe and Cho, 2011; Rabadán and Bernabèu, 2021), Australia (30) and United States of America (29) (Olabi *et al*., 2009; Jaeger *et al.,* 2021b; Rabadán and Bernabèu, 2021). Other studies in Brazil (26) (Previato and Behrens, 2015), Mexico (26) (Salgado-Beltrán, Camarena-Gómez and Díaz-León, 2016), Italy (26) (Rabadán and Bernabèu, 2021) and Finland (24) (Törnwall, Silventoinen, Hiekkalinna, Perola, Tuorila and Kaprio, 2014) reported relatively lower FNS values. Studies in New Zealand (41) (Rabadán and Bernabèu, 2021), China (37) (Prescott *et al*., 2002; Zhao *et al*., 2020), Hungary (40) (Szakály, Kovács, Soós, Kiss and Balsa-Budai, 2021) and Lebanon (36) (Olabi *et al*., 2009; Choe and Cho, 2011) reported relatively higher FNS values.

Factor analysis of the FNS-A data presented two factors. The two factors explained 51.9% of the variance, the first explaining 43.5% and the second 8.4%. Factor 1 comprises all the positively stated statements indicating that these statements are related to ‘approach’ towards unfamiliar or less familiar foods. Factor 2 comprises all the negatively stated statements indicating that these statements are related to ‘avoidance’ towards unfamiliar or less familiar foods.

The square of the loadings for statements 7 and 9 (Table *0.3*) was lower than the other statements. The low square loadings could be because statement 9, “If I do not know what is in a food, I won’t try it”, does not consider that the participants could have allergies, intolerances or might be on a special diet like veganism and vegetarianism. Statement 7 “Foods from other cultures look too weird to eat”, and statement 9 does not consider picky and fussy eaters (Demattè *et al*., 2013; Guidetti *et al.,* 2018; Lenglet, 2018). Indicating that another variable could have affected the score other than food neophobia.

Statement 4, “New foods mean an adventure for me”, and statement 10 “It is exciting to try new foods when travelling”, can be interpreted by the participants as referencing travel and new adventure. The reference to travelling could have played a significant role in answering the questions because the survey was conducted during two years of COVID restrictions (2020 to 2022), which saw multiple travel bans being put in place that restricted individuals’ movements. The strict COVID restrictions could have made participants more eager to travel, try new cultures and be more adventurous, resulting in a more favourable answer.

The FNS-A score increased as the expected liking of the unfamiliar food product decreased (Table 5.4). The FNS-A scores of the participants were related to the likelihood of choosing the five unfamiliar food items. As the FNS-A score increased, the ‘likelihood of choosing’ the unfamiliar food item decreased. A possible reason for this could be that the participants have already tried the familiar food items and have a preconceived idea of how much they like the product, while the participants have limited exposure to the unfamiliar food items. Individuals with a higher food neophobia score tend to avoid new and unfamiliar food items that they have no or limited exposure to (Pliner and Hobden, 1992). Familiar foods are usually better liked and chosen than unfamiliar foods, no matter the individual’s neophobic status (Tuorila *et al*., 2001; Nacef, Lelièvre-Desmas, Symoneaux, Jombart, Flahaut and Chollet, 2019; Tuorila and Hartmann, 2020). Neophobia develops as a fear that the unfamiliar food will taste unpleasant (Jaeger *et al*., 2017). Both Tuorila *et al*. (2001) and Olabi *et al*. (2009) indicate that individuals are more inclined to try and like products they have previously been exposed to as exposure increases their familiarity with the product.

The FNS-A score increased as the liking of the wheat pasta and wheat biscuits decreased. The FNS-A scores increased as the likelihood of choosing wheat bread decreased. This inverse relationship for the selected food items can be because individuals with higher neophobia scores enjoy both familiar and unfamiliar food and beverage items less and dislike a wider variety of food (Tuorila *et al*., 2008; Knaapila *et al*., 2011; Siegrist *et al*., 2013; Jaeger *et al*., 2017; Laureati *et al*., 2018; Spinelli *et al*., 2018; Jaeger *et al*., 2021a). Both familiar and unfamiliar foods ‘liking’ and ‘expected liking’ can be affected by food neophobia. Food neophobia is an evolutionary

mechanism developed by humans to avoid potentially dangerous substances (Dematté, Endrizzi and Gasperi, 2014).

The familiar food was liked more than the unfamiliar food items (Figure 5.1). The familiar food items were more likely to be chosen than the unfamiliar food items (Figure 5.4). Participants expect to like and be less likely to choose unfamiliar food items possibly due to emotional considerations, trust, price, taste properties and perceived benefits (Vanhonacker *et al*., 2013). The lack of certainty that the unfamiliar food item provides could be a possible reason why the participants expected to like and were less likely to choose the unfamiliar food item. Some of the concerns brought forward by participants for the reason of low 'likelihood of choosing' the unfamiliar foods were the possible higher price, the taste and other sensory differences, health-related concerns, not enough information to provide trust in the product, product loyalty and previous bad experiences with the unfamiliar ingredients (Appendix 10.5).

There was a significant difference between the low and the high neophobic groups for expected liking of the unfamiliar food items. Low neophobic participants expected to like the unfamiliar food items more than the high neophobic participants. In contrast to unfamiliar foods, the data showed that food neophobia did not affect liking of familiar food items and the sorghum porridge (a less familiar item). Food neophobia did not affect the likelihood of choosing familiar food items. However, the likelihood of choosing the unfamiliar food items decreased as food neophobia increased. This phenomenon could be because, with the unfamiliar food items, the participants are left to their imagination about the product's sensory qualities and how much they possibly will like the product. The participants might draw insight from their experience with the ingredients mentioned. It can result from past negative experiences with the ingredients mentioned in the unfamiliar foods and a lack of knowledge influencing their decision of how much they expect to like the product and the likelihood of choosing it. Food neophobia is an individual biological defence mechanism that protects humans from ingesting potentially toxic foods. The behavioural tendency to avoid certain foods is linked with a corresponding response, which is the manifestation of disliking a food (Pliner and Pelchat, 1991; Tuorila *et al*., 1994; Pliner, Lahteenmaki and Tuorila, 1998; Tuorila *et al*., 2008; Henriques *et al*., 2009; Dematté *et al*., 2014).

Low food neophobic participants are more likely to like and choose unfamiliar food compared to familiar food items because they are more willing to explore and are more curious about unfamiliar food (Pliner and Hobden, 1992; Pliner and Salvy, 2006; Jaeger *et al*., 2017; Lenglet, 2018; Samant *et al*., 2018; Pramudya, Lee, Chapko, Lee, Lee, Tokara and Seo, 2019). Participants who have more experience tasting new and unfamiliar foods tend to choose more unfamiliar than familiar food items (Loewen and Pliner, 2000; Pliner and Salvy, 2006) because it provides adventure and emotional mobility (Verbeke and López, 2005). This possibly explains why the low food neophobic individuals expected to like and choose the unfamiliar food items more than the high neophobic individuals.

High food neophobic individuals tend to have low diversity in their diet (Tuorila *et al*., 2001; Jaeger *et al*., 2017). Food neophobia only decreases when there is more exposure in the variety of foods that an individual tries (Tuorila *et al*., 2001; Olabi *et al*., 2009; Meiselman *et al*., 2010; Jaeger *et al*., 2017). High neophobic individuals tend to lack interest in food and instead focus their energy and excitement on other issues and activities (Tuorila *et al*., 2001; Choe and Cho, 2011). The difference in the likelihood of choosing familiar and unfamiliar food items can be due to highly neophobic individuals not seeing a benefit in choosing the unfamiliar food product. High food neophobia lowers participants' likelihood to like and choose foods that have been changed from their familiar recipe, as seen in previous research were the cheese (Arvola *et al*., 1999), spices and herbs (Knaapila *et al*., 2017), traditional dishes and drinks (Dominguez, Fernández-Ruiz, Sánchez-Mata and Cámara, 2019) and Turkish food (Sivrikaya and Pekerşn, 2020) were changed.

Economic factors can drive the expectation of dislike and lower the likelihood of choosing an unfamiliar food item because unfamiliar food products are generally considered more expensive. Individuals will be less likely to choose an unfamiliar food product if it potentially wastes time and money. Verbele and López (2005) showed that the more food neophobic an individual is, the more emphasis is placed on the unfamiliar food being time-consuming, having limited access to and costing more as reasons for rejection. For consumers in Malawi, price was a significant food choice motive (Gama, Adhikari and Hoisington, 2018) and can result in them being more neophobic as they cannot afford to try new and unfamiliar foods, the food item might

fail their requirements, e.g. ability to satiate. The monetary cost and time invested in the new and unfamiliar food item are considered before it is accepted because low-income consumers are quality-driven (Gittelsohn and Sharm, 2009; Xazela, Hugo, Marume and Muchenhe, 2017).

There was a difference between the low neophobic and high neophobic groups regarding liking and expected liking for the different food groups. The high neophobic group reported a more considerable difference between liking familiar foods and the expected liking of unfamiliar foods. It coincides with previous research that indicates that high neophobic individuals' overall rating for pleasantness and expected liking of unfamiliar foods are usually low (Martins *et al*., 1997; Raudenbush and Frank, 1999; Tuorila *et al.,* 2008; Knaapila *et al*., 2011; Törnwall *et al*., 2014; Jaeger *et al*., 2017). High neophobic participants tend to have poorer acceptance of food items than participants with low food neophobic scores (Knaapila *et al*., 2011; Jaeger, Rasmussen and Prescott, 2017; Samant *et al*., 2018).

The food neophobia rating of the participants did not affect the expected liking of sorghum porridge. The low neophobic group liked the maize porridge less than expected liking of the sorghum porridge. The porridge catergory had the lowest liking difference between familiar and unfamiliar versions for all three food neophobic groups compared to the other product categories. This may be because sorghum porridge, commonly referred to as mabele porridge, has relatively higher market visibility than the other unfamiliar product options Sorghum cereal has also been incorporated in various commercial cereals, e.g. Jungle Plus high protein breakfast cereal, resulting in higher exposure to sorghum in porridge than sorghum biscuits, bean/legume flour pasta and puffed snacks. The more individuals are exposed to a product/ingredient, the more willing they are to try the product, as exposure increases consumers' familiarity with the product (Tuorila *et al*., 2001). Familiarity brings an element of certainty, reduces anxiety and reduces suspicion about the food (Tuorila and Hartmann, 2020). The sorghum porridge can be considered bland compared to the other unfamiliar food items. Other researchers reported that an individual's food neophobic status generally does not impact bland staple *(e.g. like porridge in the South African context)* (Törnwall *et al*., 2014; Olabi *et al*., 2015; Jaeger *et al*., 2017; Rabadán and Bernabé, 2021).

The difference between liking/expected liking and the likelihood of choosing the two bread options was large for the high neophobic group. High neophobic individuals tend to consume low quantities of fruits and vegetables (Joshipura, Hu, Mason, Stampfer, Rimm, Speizer *et al*., 2001; Cooke *et al.,* 2006; Knaapila *et al*., 2011; Knaapila *et al*., 2015; Jaeger *et al*., 2017). Some participants indicated that they would not like the OFSP bread, citing that they do not consume vegetables like sweet potatoes as a reason (Appendix 10.5). Low neophobic individuals have an elevated liking for fruits and vegetables (Törnwall, Silventoines, Hiekkalinna, Perola, Tuorila and Kaprio, 2014), explaining the slight positive difference in 'expected liking' of the OFSP bread. High neophobic individuals prefer less complex flavoured foods and like more bland food than low neophobic individuals (Törnwall *et al.,* 2014; Olabi *et al*., 2015; Rabadán and Bernabé, 2021). The OFSP bread could have been considered a more flavourful bread by the participants. One participant stated that they would not try the OFSP bread because they believe the sweetness and flavour of the OFSP in the bread will interfere with how the bread is usually consumed, e.g., as a sandwich.

A reason for the sizeable negative difference in means between the 'likelihood of choosing' the regular bread and the OFSP bread for the low neophobic participants and the low difference in means for the medium neophobic participants might be due exposure to similar bread e.g., ube bread. Originally from the Philippines, ube bread is made from purple-fleshed sweet potatoes. The popularity of another bread made with sweet potatoes can increase familiarity and create a greater willingness to explore the product (Tuorila *et al*., 2001; Olabi *et al*., 2009). There is an increase in appreciation of unfamiliar food if participants' association with unfamiliar food is positive (Tuorila *et al*., 1994).

The higher willingness to choose the OFSP bread rather than the regular wheat bread by the low neophobic group can be due to the description provided in the survey. Low neophobic consumers can be more inclined to choose unfamiliar food items if they are persuaded to assume that the unfamiliar food item tastes good or expect health-promoting consequences (Martins *et al*., 1997), like higher vitamin A content in the bread. Barrena and Sánchez (2012) showed an increase in the willingness to choose an unfamiliar food product if the product provides a nutritional benefit or improves the

consumers' quality of life. The functional benefits also impact whether a participant is willing to choose a product, e.g. is a good value for money, improves their life, and/or is appetizing (Barrena and Sánchez, 2012).

The difference between liking/expected liking and the likelihood to choose the different versions of pasta, biscuits and puffed snacks was large for the high neophobic group. The sensory quality of the products could have been more critical in terms of emotional well-being than the nutritional quality of the products. Certain products are not liked for the nutritional benefit they provide but rather for their potential to improve the individual's emotional well-being (Gittelsohn and Sharm, 2009; Forde, 2018). Participants would not take the nutritional benefit of consuming the unfamiliar product into account or may even see the benefit as a negative if they are looking for indulgence or social belonging. Participants commented that they see biscuits and puffed snacks as a luxury and treat and making them healthier will make them taste bad (Appendix 10.5). Mela (2006) found that consumers believe that if the food is "good for you", it will not taste nice. High neophobic individuals are more likely to reject healthier alternatives of familiar foods (Tuorila *et al*., 2001; Schickenberg *et al*., 2007). Careful consideration is required when making specific nutritional claims. However, the nutritional information provided may not play an important role in some food categories (Martins *et al*., 1997).

Lack of familiarity can also result in the unfamiliar food being considered unappetising and less liked, as consumers expect to find unfamiliar foods to be less palatable than familiar ones (Pliner and Salvy, 2006). The expected palatability predicts the participant's willingness to taste the products. Participants will only try unfamiliar food items if exposed to the product for a specific time, without negative consequences, as they learn that the food is safe and palatable. The large differences between the liking and expected liking of familiar and unfamiliar foods among high neophobics can be because consumers have a negative expectation of unfamiliar food. High neophobics display a more pessimistic attitude and hold lower pleasure and taste expectations towards foods (Arvola *et al*., 1999; Raudenbush and Frank, 1999; Nordin *et al*., 2004; Barrena and Sánchez, 2012).

Individuals with a high neophobia score find cultural identification and social belonging with those around them key features when choosing unfamiliar food products (Barrena and Sánchez, 2012). When conducting a study in Belgium, France, Italy, Norway, Poland and Spain, Vanhonacker, Kühne, Gellynck, Guerrero, Hersleth and Verbeke (2013) found that individuals perceived changing the composition of traditional food as the most harmful innovation. The changing of old-fashioned foods like bread, pasta and biscuits can be met with criticism, especially by high food neophobics and influence their likelihood of choosing such items. The likelihood of choosing unfamiliar food items could have been low for the high neophobic group because the innovation of the products was too much for them. It could have made them feel like they were losing part of their cultural identity. The aspects could have affected the 'likelihood of choosing' the bean/legume pasta, sorghum biscuit and bean/legume puffed snack. As in these circumstances, emphasis was placed on using new ingredients without reassuring participants about the comfort and security it will provide them if they choose the product.

The role of disgust should also not be overlooked. Disgust is an avoidance behaviour that can be elicited by factors like texture, appearance, ingredients' origins, and contamination with a foreign matter or unpleasant previous experience (Tuorila and Hartmenn, 2020). Jaeger *et al*. (2017) hypothesized that highly food neophobic individuals have more negative food interactions throughout their lives, resulting in encounters they wish to avoid on a daily basis. The nature and familiarity of the food item that the participant is presented with can affect whether the food item is accepted or not (Barrena and Sánchez, 2012). It is possible that the participants had previous experience with the product or the ingredients and therefore liked the product more/less. One participant stated that he/she expected to dislike the sorghum porridge and biscuits because the texture and flavour of sorghum are highly unpleasant (Appendix 10.5). In comparison, another participant expected to dislike the unfamiliar pasta and puff snacks because they are made with legume/ bean flour, and they previously had digestive issues with beans. Thus, the ingredients can enlist disgust even before the product is tasted, resulting in rejection of a specific product even if their FNS-A score is low or medium.

The differences between the liking and expected liking of the familiar and unfamiliar food items indicate that the type of food used plays a role. The expected liking and likelihood of choosing are different for each food group. The product's familiarity determines the neophobic response towards a food.

Phase 2

There was no correlation between FNS-A scores and liking of the sensory properties of the wheat bread or the OFSP bread. The result is similar to Törnwall *et al*. (2014), which demonstrated that food neophobia scores do not affect the difference in the sensory characteristics between familiar and unfamiliar food. At the same time, various researchers have found that food neophobia does affect the sensory liking of both familiar and unfamiliar foods (Pliner and Hobden, 1992; Tuorila *et al*., 1994; Pliner *et al*., 1998; Arvola *et al*., 1999; Henriques *et al*., 2009; Knaapila *et al.*, 2011; Raudenbush and Frank, 2012; Siegrist *et al*., 2013; Jaeger *et al*., 2017; Laureati *et al.,* 2018; Samant *et al*., 2018; Spinelli *et al*., 2018; Fibri and Frøst 2019; Pramudya *et al*., 2019; Jaeger *et al*., 2021a).

There was no difference between how much the consumers liked the sensory properties of the wheat bread and OFSP bread, except for liking of the colour. The familiar wheat bread was expected to receive a higher liking score for the various sensory properties because consumers had previously been exposed to wheat bread. Exposure has been experimentally established to enhance consumers' hedonic response (Tuorila *et al*., 1994).

The consumers liked the appearance of the wheat bread and OFSP bread equally. However, they liked the colour of the wheat bread more than that of OFSP bread. The difference in liking can be explained by the trained sensory panel results, colourimeter and the images of the bread. The trained sensory panel identified that the OFSP bread was more cream yellow than the wheat bread. The difference in cream colour could have been the reason why the consumers liked the OFSP bread less. The bread's colour disparities were apparent, as seen in the side-by-side images of the two slices of bread. The images show the familiar wheat bread with a whiter crumb. In comparison, the OFSP bread has a darker yellow cream crumb. Interestingly a

previous study conducted in Mozambique showed high acceptability for the colour of the OFSP bread by the consumers (Owade *et al*., 2018).

The colourimeter showed a colour disparity between the two slices of bread in terms of L*, b*, chroma values and whiteness indices. The wheat bread had a significantly higher L* value than the OFSP bread, indicating that the wheat bread is whiter than the OFSP bread when measured on the greyscale. The OFSP bread had a significantly higher b* value compared to wheat bread, indicating that the OFSP bread is yellower than the wheat bread. The chroma value indicates that there was a difference in the intensity of colour between the slices of bread. The whiteness indices indicated that the wheat bread was whiter than the OFSP bread. The trained sensory panel appearance descriptors for brown specs, pore/air pockets and air pocket density for the slices of bread were similar. Possibly as to why the consumers liked the appearance of the pieces of bread the same. The image shows size irregularities between the two loaves of bread, with the wheat bread being larger than the OFSP bread. The size difference can be because of the addition of OFSP decreasing the rise of the bread.

The liking of the appearance and the colour of the OFSP bread was not affected by the food neophobic groups. It was expected that due to the colour disparities the high neophobics should have liked the colour less than the other food neophobic groups because high neophobic consumers tend to dislike unfamiliar food items more in terms of appearance (Pramudya *et al*., 2019). The similar liking of appearance of the wheat and OFSP bread by the food neophobic groups could be due to the similarity of the bread appearance. The creamier colour of the OFSP bread could have resembled other bread on the market, resulting in the consumers being less anxious about the OFSP bread colour. The consumers found both pieces of bread familiar, resulting in no effect between the food neophobic groups.

The trained sensory panel and the texture analyser found no differences between the wheat and OFSP bread in terms of texture. The consumers liked both pieces of bread equally in terms of texture and mouthfeel. The texture analyser demonstrated no differences in peak force one and peak force two during compression for the wheat and OFSP slices of bread. The results showed that the same amount of force is

required to chew the slices of bread, indicating that both slices of bread were equally soft. The results from the texture analyser coincided with the trained sensory panel, which found that the slices of bread were equally soft. There was no difference between the percentage resilience of the slices of bread, meaning both slices of bread had the same percentage capacity to recover to their original form after the compressing force is removed; thus, the bread had the same springiness. The trained sensory panel also found the slices of bread to have the same springiness, coinciding with the texture analyser. The trained sensory panel and texture analyser indicated that the wheat and OFSP bread had the same texture, thus potentially indicating why the consumers liked the texture of both slices of a bread. Previous research where there was a 30% incorporation of OFSP puree in the bread found that the OFSP bread texture was less acceptable to consumers in Ghana when compared to the wheat bread (Bonsi, Zabawa, Mortley, Bonsi, Acheremu, Amagloh and Amagloh, 2016). The OFSP bread was found to have a firmer texture (Bonsi *et al*., 2016).

The consumers' food neophobic state did not contribute to the consumers' liking of the wheat and OFSP bread in terms of texture or mouthfeel. The results do not coincide with those reported by Dovey, Aldridge, Dignan, Staples, Gibson and Halford (2012), which found that the liking of unfamiliar food textures is inversely related to food neophobia. The lack of effect of food neophobic groups on liking the texture and mouthfeel of wheat bread and OFSP bread could be due to the similarities between the two pieces of bread. The consumers might have felt that both pieces of bread were equally familiar. The nature and familiarity of the food item can affect whether the food item is accepted by neophobic individuals (Barrena and Sánchez, 2012).

The trained sensory panel rated both slices of bread as similar in terms of aroma. The same aroma could be the reason why the consumers liked the aroma of wheat and OFSP bread the same. Consumers' food neophobic state did not contribute to the consumers liking of the aroma of the wheat and OFSP bread. An inverse relationship between aroma liking and food neophobia was expected, as high food neophobic individuals' rated unfamiliar odours less pleasant (Dematte *et al*., 2014). Familiar food aromas are usually evaluated as more pleasant than food odours never encountered before (Dematte *et al*., 2014). The consumers could have assumed both pieces of bread are equally familiar because of how similar the aroma was and rated both

products as familiar products. Familiarity has been experimentally established to enhance consumers' hedonic response (Tuorila *et al*., 1994). Neophobia mainly contributes to the liking of unfamiliar foods because neophobia is the fear or unwillingness to try unfamiliar food (Jaeger *et al*., 2017). High neophobic individuals liked unfamiliar food less than low neophobic individuals (Pliner and Hobden, 1992; Tuorila *et al*., 1994; Pliner, Lahteenmaki and Tuorila, 1998; Tuorila *et al*., 2008; Henriques *et al*., 2009; Demattè *et al.,* 2014). So if the consumers find both pieces of bread familiar, then food neophobia does not apply, and the products will be rated the same.

The consumers liked the flavour of both wheat bread and OFSP bread. The trained sensory panel found that the overall flavour and sourness of the wheat bread and OFSP bread were different. However, the salt, sweet and bitterness taste and toasted and grain flavours were all found to be similarly intense. These tastes and flavours could be more essential attributes for the consumers, resulting in them liking both slices of bread flavour. The different overall flavour and sourness could have reminded the consumers of other bread on the market, resulting in the bread being familiar to the consumer and the consumer still liking the bread.

There was no difference between the likings of flavour of the OFSP bread by the food neophobic groups. A difference in liking of the flavour by food neophobic groups was expected because unfamiliar food items generally tend to receive a significantly lower scoring for flavour from high neophobic individuals than from low neophobic individuals (Henriques *et al*., 2009; Pramudya *et al*., 2019). The OFSP bread received a higher overall flavour rating compared to the wheat bread. It indicated that the OFSP bread had a more intense flavour profile; this should have made the high neophobic group to dislike the OFSP bread significantly more compared to low and medium neophobic groups because high neophobics tend to be less tolerant of intense and complex flavourful foods (Törnwall *et al*., 2014; Olabi *et al*., 2015; Rabadán and Bernabé, 2021). The OFSP bread received a higher rating for the sour/fermented flavour of the bread; this was expected to have negatively impacted the high neophobic group's liking rating for flavour because low neophobic individuals like pungent, sour and umami foods more than individuals with a higher neophobic score (Törnwall *et al*., 2014).

The food neophobia state of the consumers did not affect the liking of the sensory properties of the OFSP bread. The OFSP bread was considered to be not as novel as predicted. High neophobic individuals tend to show more anxiety towards novel food (Tuorila *et al*., 2001; Choe and Cho, 2011), resulting in familiar products being liked more. The acceptance of novel foods is not just affected by food neophobic tendencies (Arvola, Lähteenmäki and Tuorila, 1999) but also by the environment, the characteristics of the food and the consumer (Deegan, Palmujoki, Isotalo and Tuorila, 2015). The consumers might not have considered that a familiar staple food like bread could be a novel product. The acceptance of the bread could have been affected by the environment under which the test was performed as consumers conducted the test from their own homes, which could have resulted in them feeling safe and less anxious. The consumers will accept the OFSP bread regardless of their food neophobic state. Regular consumption of the OFSP bread can possibly result in a reduction in vitamin A deficiency.

General discussions

In this general discussion of the study the methodologies used will be critically evaluated. The latter part of the discussion will reflect on the value of the study and identify recommendations for further investigations.

Critical evaluation of the methodologies

Measurement of food neophobia

In this research food neophobia status of respondents was measured with a slightly altered scale compared to the one by Pliner and Hobden (1992) that is mostly used. The reason for using ten statements FNS-A (Table *0.2*) was because it was a scale developed to serve as an updated version and developed from inputs from respondents in the southern African region. Subsequently, the results of a subsection of this study were incorporated in a publication (De Kock, Nkhabutlane, Kobue-Lekalake, Kriek, Steyn, Van Heerden, Purdon, Kruger, Kinnear, Taljaards-Swart and Tuorila, 2022) describing the development and validation of the FNS-A.

The individual FNS-A values were computed as the sum of the ratings given to the ten statements after the five negative statements had been reversed. No standardized method exists for how food neophobic groups should be categorised, with various methods existing. Some studies divide FNS participants into either two, three, five or six categories. The majority of studies make use of the sample mean score of the FNS or divide the participants into two groups' low and high neophobic based on if they fall under 35 or above 35 or classify participants as food neophobic when they scored 20 or higher on the FNS (Pliner and Hobden, 1992; Tuorila *et al.,* 2001; Ritchey *et al.,* 2003; Henriques *et al.*, 2009; Meiselman *et al.*, 2010; Olabi *et al*., 2015; Jaeger *et al.*, 2021b; Jaeger *et al*., 2021a). However, the method most commonly used in other research was selected. The food neophobic groups were determined using the mean scores and standard deviation, e.g., Tuorila *et al.,* 2001; Ritchey *et al.,* 2003; Henriques *et al*., 2009; Meiselman *et al.*, 2010; Jaeger *et al.*, 2021a. Low neophobic 10 > (mean-standard deviation), (mean-standard deviation) $\leq$ medium neophobic $\geq$ (mean + standard deviation) and high neophobic (mean+ standard deviation) <70 (Tuorila *et al*., 2001). Thus the participants were divided into three food neophobia subgroups; low, medium and high, based on the FNS-A scores.

Phase 1

In phase 1 of the study the purpose was to see if food neophobia can be used as a predictor of acceptance and likelihood to try novel food concepts with nutritional or sustainability benefits. The food items targeted were generally popular with consumers: bread, porridge, pasta, biscuits, and puffed snacks. The novel concepts were OFSP bread, sorghum porridge, legume/bean pasta, sorghum biscuits, and legume/bean puffed snacks. Apart from sorghum porridge, the novel food concept were not readily available in South Africa at the time. The choice of food concepts was suitable for the purpose.

The process of collecting data

In the study, prejudice by subjects was possible as the survey was marketed as an online survey about food, with the motivation to participate by reminding consumers that their participation could inform product development in supporting nutritionally balanced diets in Africa. Highly neophobic consumers may have been reluctant to partake in the survey. Consumers that are highly neophobic generally, are not keen to

participate in food surveys, especially if they think they might have to taste something unfamiliar (Tuorila *et al*., 2001). Highly neophobic individuals are less willing to try unfamiliar foods (Tuorila *et al*., 2001). A chance to win a R500 Takealot shopping voucher was used as an incentive to get individuals to participate.

The majority of the participants that participated in the online survey and bread evaluation were aged between 19 to 25 years. The demographic of respondents, therefore does not represent the population of South Africa. Results obtained for food neophobia assessment and bread evaluation may be different for respondents for more diverse in age and socio-demographic status.

Black and white click art images were used to provide the participants with a basic idea of the food product concept. A short description of the unfamiliar food concepts was provided to the participants with information to make an informed choice. The information consisted of a short description regarding the reason for using an ingredient and/or the nutritional or sustainability benefit/s. The description was potentially not enough information to familiarise the participants with the product concept. Verbal and image descriptions of products are probably not a strong stimuli compared to exposure to real physical foods. Nacef *et al*. (2019) proposed that physical exposure to a product is the primary building block of familiarity, while theoretical knowledge is a secondary factor, indicating that the short description provided at the beginning of each food section was not enough to familiarize the participant with the food and that the product can still be seen as unfamiliar. Deegen *et al.* (2015) showed that mentioning the novelty element of food does affect whether a participant is willing to purchase the product, but not the expected liking of the product.

Participants were pre-screened on how often they consume bread, porridge, pasta, biscuits and puffed snacks. This question was used to exclude participants that were not regular users of a product category, who potentially dislike the product category and/or those that never consume the product category for any reason. It also ensured that the participants were familiar with the product categories.

The online survey used a 9-point scale as a response option for the questions 'How much do you like? / How much do you expect to like the product?' (Hein *et al*., 2008; Henriques *et al*., 2009). The advantage and disadvantages of the use of this scale have been discussed extensively in the literature. The 9-point scale is a balanced bipolar scale, with a neutral centre and four negative and four positive categories on either side. The categories represent a single continuum and deduce consumer acceptance as "liking". The scale accepts that the participant preference can be categorized into dislike and like categories (Gámbaro and McSweeney, 2020). The 9-point scale's simplicity and limited choices make it easy for participants to respond and require no extensive training (Lim, 2011). The participants directly evaluate their experience with the product and then allocate the degree of that experience to one of nine labelled categories that represent different denotation magnitudes along a dimension (Cardello and Jaeger, 2010). A 9-point scale produced the best reliability, discriminability and validity for a measurement model in confirming factor analysis compared to other scales (Malik, Mustapha, Sobri, Razak, Zaidi, Shukri, Luqman and Sham, 2021). However, it is criticised for the absence of equal intervals among the categories (Meullenet, 2004). The 9-point scale neutral category of "neither like nor dislike" encourages complacency of judgement, resulting in decreased scale efficiency as consumers can dump stimuli on the borderline into a safety category (Cardello and Jaeger, 2010). Participants tend to avoid the end categories of the scale, reducing the 9-point scale to a 7-point scale. Participants also avoid extreme negative responses due to politeness (Wichchuckit and O'Mahony, 2014).

Participants were asked about both the familiar version and unfamiliar product version and what the likelihood is that they will choose the products if the prices are the same by responding on a 5-point scale of (1) 'Very unlikely' to (5) 'Very likely' (Tuorila *et al*., 2001; Schickenberg, van Assema, Brug and de Vries, 2007). The question could have been stated differently e.g. 'What is the chance you would choose product X?' The question used was potentially too general, and the participants could have interpreted the question differently. A more precise question could have been, 'How willing are you to purchase this product?' Purchase intent is a better measure of consumer acceptance of a product than expected willingness to try (Deegen *et al*., 2015). Lower purchase intent is expected by highly neophobic participants for unfamiliar and new products, as neophobia influences the expectations of food (Tuorila, Anderson and

Salovaara, 1998; Arvola *et al*., 1999; Raudenbush and Frank, 1999; Deegen *et al*., 2015). This was shown when the higher food neophobia participants' purchase intent dropped when the same cheese was marketed as a 'New type of cheese' compared to just 'cheese' by Deegen *et al*. (2015). Purchase intent is a good option to determine market behaviours because participants might like various products, but when they have to choose, their preference is biased by many factors e.g. information (Tuorila *et al*., 1998). "Wanting" a product is not always determined by liking the product (Berridge, 1996; Mela, 2006); thus, purchase intent might predict market behaviour well. A preference or choice option between familiar and unfamiliar food is an alternative option to include to determine how food neophobia affects selection. The acceptance-preference task can evaluate purchase decisions and attitudes (Stone, Bleibaum and Thomas, 2021).

The bread product evaluation test was run with 82 consumers. The number of respondents resulted in the consumer test making a valid statistical inference. A consumer study to make a valid statistical inference requires at least 75 consumers per stimulus to approximate normality (Lim, 2011). Each consumer had to rate their liking of the sensory properties of the bread samples using a 5-point scale with a neutral middle and two positive and two negative statements on either side (Tuorila *et al*., 2008; Lim, 2011). The 5-point scale was used to determine liking instead of the 9-point hedonic liking for its simplicity. The 5-point scale requires less reading and a quicker response from the consumer. In addition to word anchors,the scale also contained five facial expressions in progressions from frowns to smiles with the statements; this was intended to reflect progressions of liking. The facial expressions help to simplify the test and assist consumers with lower literacy levels. The 5-point face scale was found by Chen, Resurreccion and Paguio (1996) to be best for use by participants with cognitive disabilities. This method allows the information to be obtained without unjustifiably biasing the response behaviour. There is the potential for misinterpretation between the faces on a face scale and the degree of actual liking (Stone *et al*., 2021). Facial scales have not been shown to provide an advantage over verbal scales in consumer research (Stone *et al*., 2021). The face scale was developed for young children and consumers who are low literate or cannot understand the meaning of the written statements in scales. The scale was mainly completed by university students, which meant a certain level of literacy was expected and that they

would have been able to complete a more comprehensive e.g. 9-point hedonic scale, without the potential for misinterpretation. The 9-point scale is preferred over the 5-point scale by some researchers because of its accuracy and precision (Lim, 2011). The 9-point hedonic measure is possibly the best sensory method to determine liking and preference (Stone *et al*., 2021). The main reason for using the 5-point verbal scale accompanied by a face scale was because researchers wanted to compare the responses with results obtained from a scale that had to coincide with a previous year's consumer testing of the wheat and OFSP bread. The method was repeated to ensure consistency in the method of generating results compared to results received from previous test. The consumers were provided with an incentive once they completed the test, which motivated them to complete the test

Statistic interpretations

Pearson correlation measures if two sets of data have a linear correlation. The Pearson coefficient is a relationship between the covariance of two variables and the result of their standard deviations. It can indicate if the relationship between two variables is positive or negative and how strong the relationship is. The Pearson correlation provided a measurement tool to see the relationship of the food neophobia scores of the participants with the liking/expected liking, likelihood of choosing familiar and unfamiliar foods as well as liking the different sensory properties of bread types. The Pearson coefficient only reveals a linear correlation between the two variables and ignores other variables (Chen and Popovich, 2002). High noise results can result in Pearson coefficient inaccuracy.

The one-way analysis of variance (ANOVA) test was performed at a 5% significance level to analyse the differences among means for the liking and likelihood of choosing the familiar and unfamiliar food categories between the different food neophobic groups. The pairwise Tukey post hoc test was applied to separate means. It is common practice to use analysis of variance with 5-point and 9-point scales because the data are discrete and categorical with no true zero point (Lin, 2011). One-way analysis of variance is the preferred method to test the mean values of acceptability for familiar and unfamiliar products and determine if there are significant differences between familiar and unfamiliar food and food neophobia (Gámbaro and McSweeney, 2020).

The division analysis of the acceptability data allows for the sectors with different preference patterns to be known and determine the qualities that direct consumers' preferences through different information on familiar and unfamiliar food products (Gámbaro and McSweeney, 2020). The Tukey test determines which samples have significant differences and the error rate. As ANOVA does not identify which groups regarding significant difference exist, it only indicates a significant difference among the means. Tukey test compares all the treatments to the other treatments' means to determine the distance between groups'. Tukey's post hoc test is the most preferred post hoc test as it is the most conservative in its assumptions between groups (Cook, 2007).

Factor loadings of the ten statements' by exploratory factor analysis (EFA) were determined to study the interrelationships between the statements (Cudeck, 2000). Two factors were extracted based on the EFA method because it assumes the total variance can be divided into common and unique variance; specific and error variance (Bruin, 2006). In contrast, the principal component analysis (PCA) assumes that the total variance only consists of common variance (Cudeck, 2000; Bruin, 2006). EFA was used because it was believed that there could be some latent construct that defines the interrelationships among the statements. The variables would have been reduced with PCA into linear combinations of smaller components. Oblique rotation was used to interpret the factor loadings because the factors are correlated and not independent from each other. The factors are not orthogonal to each other in the oblique rotation, meaning the x- and y-axis are not at 90˚ angles to each other (Bruin, 2006). The oblique rotation obtains a more straightforward and significant factor solution than the unrotated solution (Bruin, 2006). The oblique rotation produces the square of the loadings, representing the influence of the particular factor on the variance of the statement, but it excludes the overlap amongst correlated factors (Cudeck, 2000; Bruin, 2006). A Direct Quartimin analysis was performed, run with delta at zero. The delta value increases the correlation among factors, and in general, highly correlated factors are not desired as this results in there being no reason for splitting the factors up (Bruin, 2006). The more correlated the factors, the more significant the difference between the pattern and structure matrix and the harder it is to interpret the factor loadings (Cudeck, 2000; Bruin, 2006).

Phase 2

Descriptive sensory evaluation of bread

A trained sensory panel was used to select and quantify the key attributes of the wheat and OFSP bread. Unfortunately, the OFSP bread was unavailable during the descriptive term development sessions and it was necessary to adapt the usual generic descriptive analysis process. Panellist selected the key attributes based of the evaluation of store bough wheat bread. The absence of OFSP bread in the selection of the key attributes for the wheat and OFSP bread could have resulted in the inaccurate selection of attributes for the bread. The trained sensory panel only had one day to work on the sensory terms. Due to the limited supply of bread and the limited shelf-life of bread, the trained sensory panel could only evaluate one slice of each bread. Preferably the bread should have been tasted in duplicates to minimize the chance of error. The selected attributes allowed each panellist to evaluate each sample for appearance, smell/ aroma, flavour, texture (the bite and chew of the sample) and flavour on an unstructured line-scale anchored at the ends. Using a validated descriptive analysis for the wheat and OFSP bread could have resulted in test results that were more accurate and reproducible. Various techniques are available to conduct a trained sensory panel like Quantitative Descriptive Analysis (QDA) and rapid descriptive methods e.g. Check-All-That-Applies (CATA) and Optimized Descriptive Profile (ODP).

QDA is an effective tool used to obtain a detailed sensory description and is widely seen as the “gold standard” for sensory evaluation of various food products (Meilgaard *et al*., 2007b; Stone *et al*., 2021). QDA main principle is based on its high capability to train panellists to quantify particular attributes of a product in a reproducible way and to produce a complete qualitative and quantitative sensory product profile whose discriminative capabilities are statistically validated (Meilgaard *et al*., 2007b; Stone *et al.,* 2021). QDA procedure (Meilgaard *et al*., 2007b; Hein *et al*., 2008) requires a specific two-stage process. Stage 1 involves developing descriptive terms using the samples to be evaluated. Stage 2 is the sensory evaluation of these samples using the sensory terms established in stage 1 rated on suitable rating scales (Meilgaard *et al*., 2007b; Hein *et al*., 2008). Descriptive terms were developed with the use of store-bought wheat bread. QDA requires at least two to three days of training with the panel,

the samples to be evaluated and scale references (Meilgaard, Civille, and Carr, 2007b). However, the use of QDA is laborious, costly and timely because of the time required to train the panel, and faster and less expensive rapid methods have been gaining significance as a substitute, without affecting the reliability of the results (Aguir, Melo and de Oliveira, 2018).

The rapid analysis consists of various techniques e.g. Check-All-That-Applies (CATA) and Optimized Descriptive Profile (ODP). CATA analyses the frequencies with which the sensory terms listed are used, providing information regarding the perception of the product, but because CATA is centred on the frequency and not rating, the technique does not permit quantitative measurements (Aguir *et al.,* 2018). It has been reported that CATA has low discrimination power for similar samples (Aguir *et al.,* 2018). The ODP has an optimized evaluation protocol that only requires a brief training session with the panellists while addressing the magnitude of the sensory attributes (Aguir *et al*., 2018). With ODP, the reference samples are available during data collection for consultation, whereas with QDA the panellists undergo extensive training before the final evaluation with the reference samples. The need for sensory memory formation is eliminated with ODP, while also helping with the better allocation of perceived intensities by the panellist on the scale. Research has shown that ODP provides similar results to QDA, with a significant time reduction (Aguir *et al*., 2018). ODP has scarcely been used when compared to CATA and has not been used for the sensory evaluation of bakery products (Aguir *et al*., 2018).

Physical analyses

A colourimeter is used to correlate the colour of products to human perception. Colour is the consequence of how visible light wavelength is reflected, absorbed and refracted, with surface texture also impacting the visual colour difference (Choudhury, 2014). The colourimeter tool measured any colour differences between the two types of bread in terms of wavelength. The imaging colourimeter system comprehensively calculates the bread's colours and distribution in numerous colour coordinate systems. It indicated that the colour comparison between the two pieces of bread is similar in terms of wavelength measurement and human perception. The chroma (C^*) value was

used to measure how strong the colour intensity of the bread samples was (Pathara *et al*., 2013).The chroma (C*) value is calculated with a unique formulation involving the a^* (measures red and green wavelengths in the bread samples) and b^* (measures blue and yellow wavelengths in the bread sample) (Pathara *et al*., 2013). Whiteness indices (WI) were used to measure the degree of whiteness of the product. Determination of the whiteness was vital as it was expected that the OFSP would make the wheat bread less white. The WI value is calculated with a unique formulation involving L^* (measures lightness and darkness), a^* and b^* (Battle, 1997).

A double-cycle compression test was performed to imitate the succesive mastication or chewing process of the bread (Chen and Opera, 2013), to assess the bread's hardness and springiness. Hardness is the maximum force required to compress the bread. Springiness is the bread's ability to recover to its original form after removing the compressing force (Chen and Opera, 2013). The cohesiveness, gumminess and chewiness should have been calculated to gain a better understanding of the different textural properties of the two types of bread. According to the American Association of Cereal Chemists, the method used was the measurement of bread firmness and the instrumental measurement of white pan bread (AACC Method 74-09.01; Gámbaro, Varela and Giménez, 2002). Various adapted versions of this AACC method exist with the probe size, the test speed, the applied force, trigger force and compression deformation varying and influencing the measurements. A compression deformation force of 40% is ideal as the contact the probe has with the sample is increased, but the maximum deformation is not greater than the breaking point of the slices of bread. The cohesiveness is not obtained when the maximum deformation is greater than the breaking point of the slices of bread, because the second cycle of compression is just compressing the sample that is left and not measuring the strength of the internal bonds of the bread (Trinch, 2012). Research has shown using a cylinder probe with a diameter of 36mm is more affective in measuring the texture of the bread (Jekle *et al*., 2018). The diameter of the cylinder probe affects the hardness measurement obtained as hardness varies depending on the size of the contact surface between the sample and the cylinder probe (Trinch, 2012). The texture profile analysis (TPA) did not resemble the Szczesniak two-bite test TPA mastication profile, because the original force-time plot was based on results obtained from brie cheese (Trinch, 2012). The

bread had to be manually cut with a knife into 15mm slices, measured with a ruler, this could have resulted in the slices being inconsistent in size and uneven. Inconsistent sizes and unevenness could have affected the results obtained from the texture analyser. The ideal height for each slice of bread is 12.5mm to perform the texture analysis according to AACC method 74-09.01 (Jekle *et al.,* 2018). A bread slicer was required to ensure that the bread slices were consistent in size.

Value of the study and recommendations for further investigations

Individuals with high food neophobia scores are less likely to choose unfamiliar food products. Indicating that the first hypothesis is true in this study, as previously found in studies conducted by Tuorila *et al*., 2001; Knaapila *et al*., 2011; Jaeger *et al*., 2017. As the food neophobia score increased so did the expected likelihood of choosing the unfamiliar food items decrease when compared to the familiar food items. Among the three food neophobia groups, the difference in 'liking/expected liking' of unfamiliar versus familiar food items follows the same trend as the differences in the expected 'likelihood of choosing' the familiar and unfamiliar food items. Low neophobic individuals were expected to like and were more likely to choose unfamiliar food items than high neophobic individuals. The study demonstrated that an individual's food neophobic score does affect how much they expect to like and their likelihood to choose an unfamiliar food item and can assist in predicting whether new food products will be accepted or rejected. Various studies have demonstrated that food neophobia affects how a product is accepted (Henriques *et al*., 2009). Expected liking is the main predictor for choosing familiar and unfamiliar foods.

The success of new food items and new food technologies depends on consumers' behavioural responses (Chen *et al.*, 2013). The widespread acceptance of new food items and food technologies can be hindered due to negative attitudes towards the products and can result in product failures. It's therefore important to understand why individuals accept or reject new and unfamiliar foods and identify different population segments that are more neophobic. It can be useful in terms of product development and marketing of products to consumers, improving the success rate of new food products and has the prospective to be an essential predictor of engaging in healthier eating (Evans *et al.* 2010). A product can be marketed to a broad range of consumers

with the use of psychrographic dimensions of consumers, like food neophobia, that creates a message which highlights favourable aspects of the unfamiliar or new food product. The food neophobic state of the population can also provide an indication of just how aggressive the marketing campaigns should be, to assess whether free sample tastings and free coupons should be provided to enhance the product familiarity with consumers. However, before any marketing campaign can be established the food items type of innovation must be determined and the specific demographic group that is being targeted must be well define.

Barrena and Sánchez (2012) found that high neophobics attached an extreme importance with 'label information' in their decision making process as compared to low neophobics, confirming previous research that showed that availability of information can increase consumers' willingness to try new and unfamiliar food products (Tuorila *et al*., 1994; Pelchat and Pliner, 1995). Sense of cultural identification is also seen as extremely important psychological attribute for highly neophobic individuals, in terms of willingness to try new and unfamiliar food items (Barrena and Sánchez, 2012). This information can help in the guiding marketing campaigns. Tuorila *et al*. (1994) found that (1) providing information regarding the product, (2) how the unfamiliar product resembles familiar foods and (3) exposure to the product, are factors that can help in reducing negative responses to unfamiliar products. A label can greatly enhance the acceptance of unfamiliar food items with descriptive labels provoking a higher acceptance rating. The label can provide information to the consumers' that are based on previous experiences and knowledge that can provoke a range of associations and expectations that can contribute to affective response. The information can reduce the uncertainty about the unfamiliar product. The degree to which uncertainty is affected differ by personality traits e.g. food neophobia.

High neophobic individuals also tend to have a high fear of tasting new and unfamiliar foods (Choe and Cho, 2011), thus the lower probability of choosing the unfamiliar food item. High neophobic populations might require products that seem more familiar to them for example the OFSP bread, which might have been seen as more familiar by the participants. Martins and Pliner (2005) showed that familiarity of food to be the most important factor to predict individuals' willingness to consume familiar and unfamiliar food items. The familiarity a product provides can result in the choosing of

the familiar food even if participants express low levels of liking, whereas unfamiliar foods require a higher increase in like before buying (Tuorila *et al*., 2008). Providing information regarding the product, how the unfamiliar product resembles familiar foods and exposure to the product, are factors that can help in reducing negative responses to new and unfamiliar products by high neophobic individuals' (Tuorila *et al*., 1994; Pelchat and Pliner, 1995; Martins *et al*., 1997; McFarlane and Pliner, 1997; Raudenbush and Frank, 1999). Marketing to high neophobic individuals might require using terms that are familiar and reassuring. The product should be marketed from perspective of comfort and empathising familiar ingredients for high neophobic populations. More neophobic individuals should receive a peace of mind when adopting a new and novel product, which can include manufactures guarantee, emphases on quality and nutritional value that the product can provide. The acceptance of the OFSP bread by high neophobic individuals can be enhanced by educating the consumer about the benefits of the bread and providing reassurance regarding the colour of the bread.

Low neophobic populations will require innovative new products to capture their sense of adventure. Low food neophobic individuals found it useful when food product developers and marketing campaigns described the novelty of the process used in the making of the products (Deegen *et al*., 2015). As more low neophobic individuals can be attracted with marketing campaigns that emphasise the product uniqueness by mentioning the special ingredients (e.g. spices) incorporated, how authentic and exotic the food is or by giving more information about why the product is new and exciting. While medium neophobic individuals still require the reassurance of familiarity, but is willing to try unfamiliar food items.

The food neophobia score did not affect the liking of the sensory properties of the familiar wheat bread and unfamiliar OFSP bread during physical product evaluation, disproving the second hypothesis stating that food neophobia will affect how much the consumers like the OFSP bread. This was in contradiction to the finding of previous studies (Pliner and Hobden, 1992; Tuorila *et al*., 1994; Pliner *et al*., 1998; Arvola *et al*., 1999; Henriques *et al*., 2009; Knaapila *et al.,* 2011; Raudenbush and Frank, 2012; Siegrist *et al.*, 2013; Jaeger *et al*., 2017; Laureati *et al*., 2018; Samant *et al*., 2018; Spinelli *et al.*, 2018; Fibri and Frøst 2019; Pramudya *et al*., 2019; Jaeger *et al*., 2021a).

The OFSP bread was liked more than the wheat bread and food neophobia did not affect the liking of the OFSP bread, indicating that the OFSP bread can be launched into the food retail and help in the reduction of vitamin A deficiency. The unfamiliar OFSP bread liking rating could have been unaffected by the food neophobic level of the participants because of the familiarity of the product. Tuorila *et al*. (1994) reported that familiarity with the other food items could reduce negative responses of highly neophobic individuals. The results thus indicate that the individuals react differently to products that are to some degree familiar to them, despite their food neophobic scores. Further investigation is required with more diverse food items to determine if the familiarity of a product effects the liking by different food neophobic groups. Determining the effects of food neophobia on the liking of new and unfamiliar food items can assess to what degree the change in the food product is too much for the food neophobic groups. Further research regarding the acceptance of OFSP bread and food neophobia can be performed on bread with a higher percentage OFSP to increase the vitamin A concentration of the bread. The OFSP bread requires further evaluation in the food retail market, where competing brands will influence whether individuals would choose the OFSP bread. OFSP bread can help in the reduction of vitamin A deficiency, however a more diverse range of food items that are high in vitamin A must be developed to better address the vitamin A deficiency.

CONCLUSIONS AND RECOMMENDATIONS

Food neophobia can indicate whether a new and unfamiliar food item is expected to be liked by consumers. High food neophobic individuals are expected to like unfamiliar food items less than low food neophobic individuals. Individuals with high neophobia scores were more reluctant to choose unfamiliar food items than low neophobic individuals. Food neophobia scores can predict the liking/expected liking and likelihood of choosing certain unfamiliar food items. The effect of neophobia on choosing is depended on the product type and specifically the novelty of the sensory properties. Exposure to a product increases an individual's familiarity with the product, increasing the expected liking and likelihood that the consumer will choose the product. Further research involving more diverse food categories and food neophobia is required to establish how participants' food neophobia scores affect their likelihood of choosing unfamiliar foods. Further research is required with a more extensive and more diverse demographic in Southern Africa to represent the population accurately.

The food neophobic state of consumers did not affect the liking of the sensory properties of the OFSP bread. The consumer liking and descriptive sensory analysis indicated that the wheat bread and OFSP bread were similar, except for colour. The descriptive sensory analysis indicated that the wheat bread was less sour and had a lower overall flavour profile than the OFSP bread. The sensory properties of the OFSP bread are not as novel as expected and the extent of the novelty of the sensory properties of a new product is an important factor in the neophobic effect. The colour difference between the familiar wheat bread and the unfamiliar OFSP bread requires educating the consumer and proper labelling to explain reasons for the colour difference. The OFSP bread can be introduced into the market with a low risk of rejection of the sensory properties even by individuals with high neophobia tendencies. Regular consumption of OFSP bread may result in a reduction or prevention in vitamin A deficiency. Further research is required to determine if food neophobic individuals will choose a labelled and branded OFSP bread option within a real market situation where novel and familiar bread options offered side by side. More research on other food product options is required to address vitamin A deficiency. Further research is required with different nutritionally enhanced food items and a broader range of

consumers in Africa. To better understand whether new products, like nutritional intervention strategies, will be accepted by the market.

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APPENDICES

Appendix 10.1: Recruitment flyer distributed to recruit participants for the online survey

Appendix 10.2: The liking/expected liking, likelihood of choosing and FNS-A survey.

Department of Consumer and Food Sciences

We invite you to take part in a research study. Before you agree to take part you should fully understand what is involved.

The research forms part of the MSc Food Science project of Annelize Steyn.The purpose is to obtain understanding about the factors that impact consumers' food choices. Such insights can assist to develop a better food supply. You will be asked questions about your personal usage and consumption of some food products. The survey should take about 10 min to complete. At the end of the survey you will be given an opportunity to enter a draw where one participant will win a R500 Takealot voucher. For this, you will be asked to supply an email address.

Participation in this study is entirely voluntary and anonymous. You do not have to participate and can stop at any time. You do not have to provide any personal information in accordance with the POPIA Act. To enter the lucky draw, you will be asked to provide an email address. The email address will not be linked to your identity and will be kept confidential and not be used for any other purpose.

The study was approved by the Ethics Committee of the Faculty of Natural and Agriculture Sciences, NAS 119/2021.

If you have any questions about the research, please contact the project supervisor
Prof H L de Kock

riette.dekock@up.za (mailto:riette.dekock@up.za).

By continuing with this survey you consent to participate.

Click the *next* button to begin

Please answer the following questions about bread.

On average, how often do you eat bread?

Never	1-4 times a month	Several times a week	Daily	Several times a day

Next

How much do you like or dislike bread?

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

Next

Vitamin A deficiency is a major health issue in South Africa.

Vitamin A is an essential nutrient for eye health, vision, immune function, reproduction and fetal development.

A new bread has been developed that is naturally high in vitamin A as it contains orange-fleshed sweet potato as an ingredient.

Next

How much do you expect to like or dislike bread that contains orange fleshed sweet potato as an ingredient?

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

Any specific reason why you expect to not like bread containing orange fleshed sweet potato?

Next

If the price is the same for wheat bread and for bread with orange flesh sweet potato;
What is the chance that you would choose wheat bread?

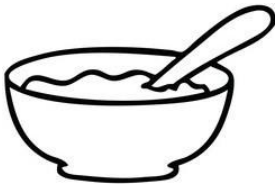
Very Unlikely	Unlikely	Undecided	Likely	Very Likely

What is the chance that you would choose orange flesh sweet potato bread?

Very Unlikely	Unlikely	Undecided	Likely	Very Likely

Next

Please answer the following questions about maize porridge/ pap.



On average, how often do you eat maize porridge/pap?

Never	1-4 times a month	Several times a week	Daily	Several times a day

Next

How much do you like or dislike maize porridge/pap?

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

Next

In South-Africa pap/porridge is mostly made from maize.

Maize is not native to the African continent as it originated in Mexico.

Sorghum (mabele) is a cereal grain native to Africa that is a drought tolerant crop and sorghum products are a good source of energy and antioxidants.

Next

How much do you expect to like or dislike porridge/pap made from sorghum?

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely
☐	☐	☐	☐	☐	☐	☐	☐	☐

Any specific reason why you expect to not like porridge made from sorghum?

Next

If maize porridge/pap and sorghum porridge/pap are both available and cost the same;
What is the chance that you would choose maize porridge/pap?

Very Unlikely	Unlikely	Undecided	Likely	Very Likely
☐	☐	☐	☐	☐

What is the chance that you would choose sorghum porridge/pap?

Very Unlikely	Unlikely	Undecided	Likely	Very Likely
☐	☐	☐	☐	☐

Please answer the following questions about pasta.

On average, how often do you eat pasta?

Never	1-4 times a month	Several times a week	Daily	Several times a day
☐	☐	☐	☐	☐

Next

How much do you like or dislike pasta?

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely
☐	☐	☐	☐	☐	☐	☐	☐	☐

Next

Pasta is usually made from wheat flour.

Wheat has to be imported to Africa because the climate is not favourable for wheat production.

Pasta can be made from legume flours, like bean

flours. Beans can be grown sustainably in Africa.

Beans are a very good source of dietary fibre, vitamins and minerals and do not contain gluten.

Next

How much do you expect to like or dislike pasta made from bean flour?

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely
☐	☐	☐	☐	☐	☐	☐	☐	☐

Any specific reason why you expect to not like pasta made from bean flour?

Next

If the price is the same for wheat pasta and pasta made from bean flour;
What is the chance that you would choose wheat pasta?

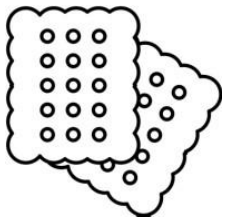
Very Unlikely	Unlikely	Undecided	Likely	Very Likely
☐	☐	☐	☐	☐

What is the chance that you would choose pasta made from bean flour?

Very Unlikely	Unlikely	Undecided	Likely	Very Likely
☐	☐	☐	☐	☐

Next

Please answer the following questions about biscuits/cookies.



On average, how often do you eat biscuits?

Never	1-4 times a month	Several times a week	Daily	Several times a day
☐	☐	☐	☐	☐

Next

How much do you like or dislike biscuits?

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely
☐	☐	☐	☐	☐	☐	☐	☐	☐

Next

Biscuits are usually made from wheat flour.

Wheat has to be imported to Africa because the climate is not favorable for wheat production.

Biscuits/cookies can be made from sorghum flour.

Sorghum(mabele) is a cereal grain native to Africa that is a drought tolerant crop and sorghum products are a good source of energy and antioxidants.

Next

How much do you expect to like or dislike biscuits made from sorghum flour?

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely
☐	☐	☐	☐	☐	☐	☐	☐	☐

Any specific reason why you expect to not like biscuits made from sorghum flour?

Next

If the price is the same for wheat biscuits and sorghum biscuits;
What is the chance that you would choose biscuits made from wheat?

Very Unlikely	Unlikely	Undecided	Likely	Very Likely
☐	☐	☐	☐	☐

What is the chance that you would choose biscuits made from wheat?

Very Unlikely	Unlikely	Undecided	Likely	Very Likely
☐	☐	☐	☐	☐

Next

Please answer the following questions about puffed snacks e.g. cheese curls and nacks.

On average, how often do you eat puffed snacks?

Never	1-4 times a month	Several times a week	Daily	Several times a day
☐	☐	☐	☐	☐

Next

How much do you like or dislike puffed snacks?

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely
☐	☐	☐	☐	☐	☐	☐	☐	☐

Next

Puffed snacks are usually made from maize.

Maize is not native to the African continent as it orginated in Mexico. Puffed snacks can be made from legume flours ,like bean flours.
Beans can be grown sustainably in South-Africa.

Beans are very good source of dietary fibre, vitamins and minerals.

Next

How much do you expect to like or dislike puffed snacks made from bean flours?

Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely
☐	☐	☐	☐	☐	☐	☐	☐	☐

Any specific reason why you expect to not like puffed snacks made from bean flours?

Next

If the price is the same for maize puffed snack and puffed snack made from bean flours;
What is the chance that you would choose maize puff snacks?

Very Unlikely	Unlikely	Undecided	Likely	Very Likely
☐	☐	☐	☐	☐

What is the chance that you would choose puffed snack made from bean flours?

Very Unlikely	Unlikely	Undecided	Likely	Very Likely
☐	☐	☐	☐	☐

Next

Please respond to the following statements.
Each time choose an answer, based on your first impression. There are no right or wrong answers, only your personal opinion counts.

New food eating experiences are important for me.

I am afraid to eat things I have never had before.

I don't trust new foods.

New foods mean an adventure for me.

I like to challenge myself by trying new foods.

I am willing to try foods from different cultures.

Foods from other cultures look weird to eat.

Foods that look strange scare me.

If I don't know what is in a food I won't try it.

It is exciting to try new foods when travelling.

Disagree Strongly	Disagree moderately	Disagree slightly	Neither disagree nor agree	Agree slightly	Agree moderately	Agree strongly
☐	☐	☐	☐	☐	☐	☐

Next

Please select your gender.

- ○ Female
- ○ Male
- ○ Prefer not to answer

What is your year of birth? (e.g. 1994)

What level of education have you completed? Please mark the appropriate option.

- ○ Primary school
- ○ Secondary/ High school
- ○ Tertiary certificate/diploma/degree

What is your home language?

- ○ English
- ○ Afrikaans
- ○ Sepedi
- ○ Sesotho
- ○ Tswana/ Setswana
- ○ siSwati
- ○ Tshivenda
- ○ Xitsonga
- ○ isiNdebele
- ○ isiXhosa
- ○ isiZulu
- ○ Other

If you wish to partake in a study involving evaluation of actual food samples please provide your email address below.

If you wish to be entered into the draw for the R500 Takealot voucher please enter your email address below.

Thanks for completing this test!

Appendix 10.3: Information pamphlet provided to the consumers

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Natural and Agricultural Sciences
Department of Consumer and Food Sciences

Good day!

Thank you for your interest in this food evaluation task.

The opinions of consumers about food products are very important for food manufacturers. Our client needs to know your opinion about the quality of **a new type of bread**. The information collected will form part of the research of postgraduate students (Ms Annelize Steyn and Ms Clarissa van Heerden) at the university.

The new bread is naturally high in Vitamin A as it contains orange-fleshed sweet potato as an ingredient. Vitamin A deficiency is a major health issue in South Africa. Vitamin A is an essential nutrient for healthy vision, teeth, skeletal tissue and skin.

Instructions: Please complete the task today.

- You have received a bag with four bread pieces to evaluate. There is a number on the bag.

BAG NUMBER	

- Each bread piece in the bag is marked with a 3-digit code.
- **Please find a comfortable place to sit, take out a plate and a knife to cut the bread and make sure to have about 20 min available for the task. You will need access to the internet for the task.**
- When you are ready, scan this QR code or go to link: https://bit.ly/BreadTasteTest

Dept of Consumer & Food Sciences
Old Agricultural Building
Room 3-36
University of Pretoria, Private Bag X20
Hatfield 0028, South Africa
Tel +27 (0)12 420 3238
Email nette.delpock@up.ac.za
www.up.ac.za

Fakulteit Natuur- en Landbouwetenskappe
Departement Verbruikers- en Voedselwetenskappe
Lefapha la Disaense tša Tlhago le Temo
Kgoro ya Disaense tša Dijo le Bareki

- Follow the process and answer all the questions. There are no right or wrong answers.
- Make sure to select the bread piece with the code as indicated.
- Please answer all the questions and remember to click finish at the end. You do not have to eat all the bread.
- At the end of the survey, you will have the opportunity to provide an email address to receive an e-voucher from Pick 'n Pay to thank you for the time and effort.

We consider the health and safety of all research participants to be of utmost importance. The products were manufactured at a facility that complies with all SA food regulations.

The products contain ingredient that are similar to what you find in other commercial bread products and may contain:
wheat flour, sweet potato puree, yeast, sodium chloride, sucrose, vegetable fat and/or oil (palm fruit, canola seed and/or sunflower seed), soya flour, starch, wheat flour, anti-caking agent (E170), preservative (E282), oxidizing agent (E300) , enzymes, vitamins and minerals.

Allergens: wheat (gluten), soya

Please do not participate if you want to or need to avoid consuming any of the ingredients as listed.

Your responses to questions will be treated as confidential information and will not be linked to your identity.

The study was approved by the ethics committee of the faculty of Natural and Agricultural Science of the University of Pretoria (NAS 119/2021)

If you require any further assistance please contact

Annelize Steyn u13017862@tuks.co.za or

Clarissa van Heerden at u16020180@tuks.co.za

If you have any questions about the research please contact:

Prof H L de Kock riette.dekock@up.ac.za

Appendix 10.4: Liking of the wheat and OFSP bread and FNS-A survey

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Denkleiers • Leading Minds • Dikgopolo tša Dihlalefi

Department of Consumer and Food Sciences

Welcome!

Thank you for participating in this food evaluation task.
Participation is voluntary. You can refuse to participate or stop at any time during the study.
The research forms part of the projects of post-graduate students Annelize Steyn and Clarissa van Heerden.
The study was approved by the ethics committee of the faculty of Natural and Agricultural Sciences (NAS 119/2021).
All information will be handled strictly confidential (in accordance with the POPIA Act).
If you have any questions , please contact the project supervisor Prof H L de Kock riette.dekock@up.za

(mailto:riette.dekock@up.za).
By continuing with this survey you consent to participate. Click the *next* button to begin

Next

Please enter your **bag number**:

Next

The opinions of consumers about food products are very important for food manufacturers.
Our client needs to know your opinion about the quality of new types of white and brown bread.
The new bread is naturally high in Vitamin A as it contains orange-fleshed sweet potato as an ingredient. Vitamin A deficiency is a major health issue in South Africa.Vitamin A is an essential nutrient for healthy vision, teeth, skeletal tissue and skin.

Next

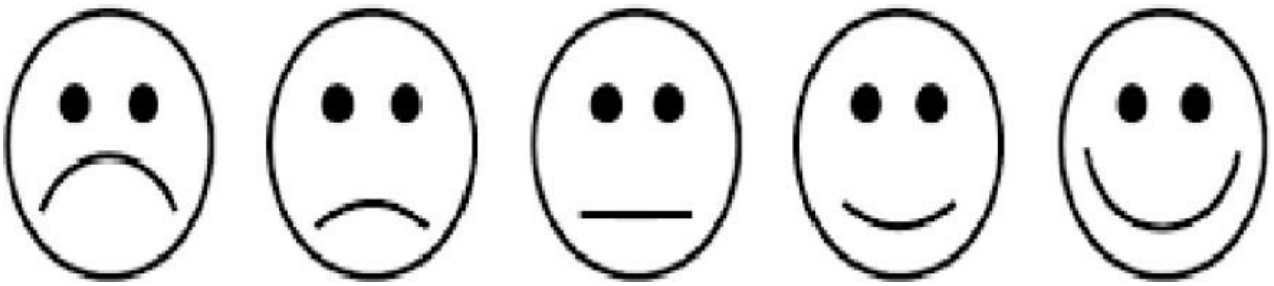
You received a bag with four bread pieces to evaluate. Each bread piece in the bag is marked with a **3-digit code**.

- Please ensure that you have a plate and sharp/ bread knife ready to cut the bread. Please remember to drink water before and in-between tasting the bread.
- Follow the process and answer all the questions. There are no right or wrong answers.
- **Make sure to select the bread piece with the code as indicated.**
- You do not have to eat all the bread.

Next

Please remove the bread marked BC111 from the bag and remove the plastic covering. Please evaluate the appearance of the bread .

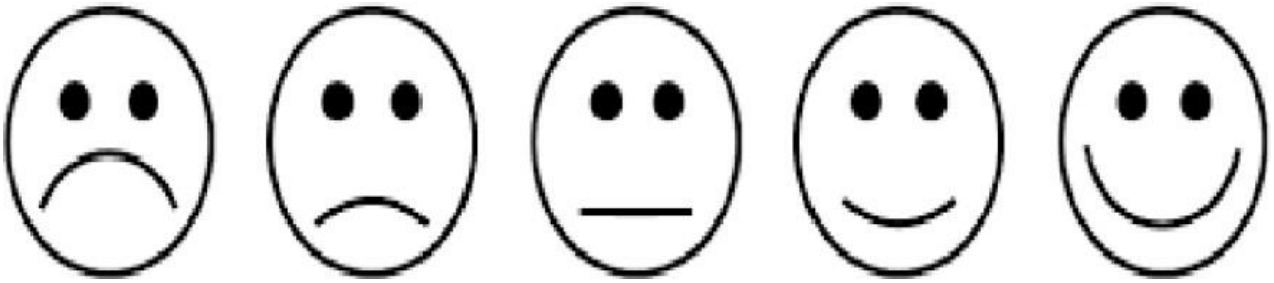
How much do you like or dislike the look/appearance of bread BC111?



Dislike Very Much	Dislike	Neither Like nor Dislike	Like	Like Very Much
☐	☐	☐	☐	☐

Next

How much do you like or dislike the colour of the bread marked BC111?

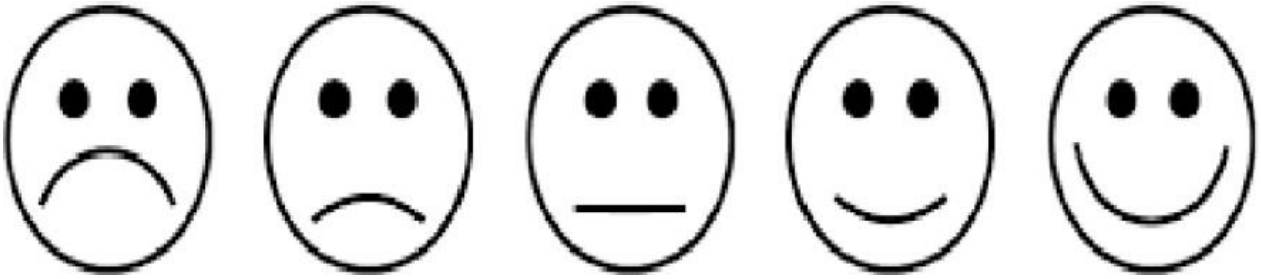


Dislike Very Much	Dislike	Neither Like nor Dislike	Like	Like Very Much
☐	☐	☐	☐	☐

Next

Please smell the bread marked BC111

How much do you like or dislike the smell/aroma of the bread BC111?

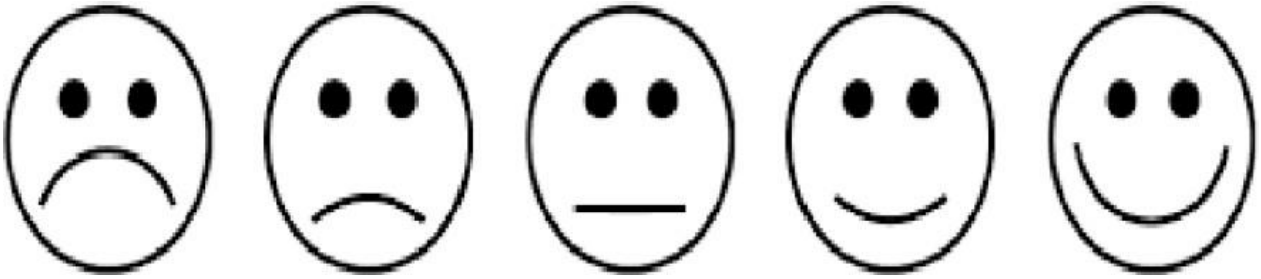


Dislike Very Much	Dislike	Neither Like nor Dislike	Like	Like Very Much
☐	☐	☐	☐	☐

Next

Please slice the bread marked BC111.

How much do you like or dislike the texture of the bread BC111 in your hands?

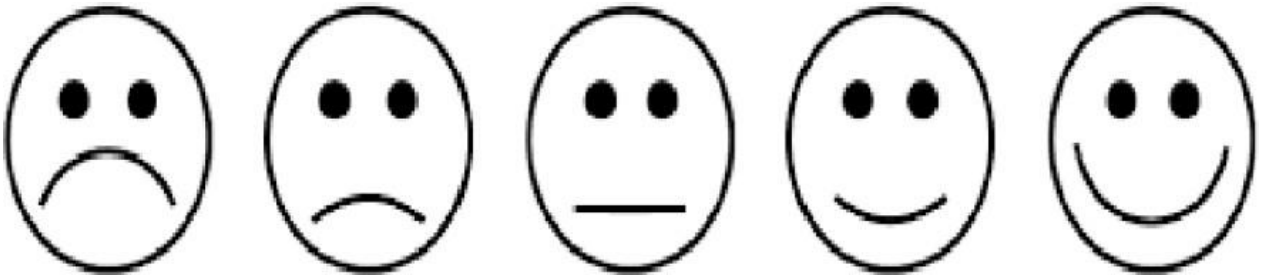


Dislike Very Much	Dislike	Neither Like nor Dislike	Like	Like Very Much
☐	☐	☐	☐	☐

Next

Please take a bite from the slice of the bread marked BC111.

How much do you like or dislike the texture of the bread BC111 while chewing?

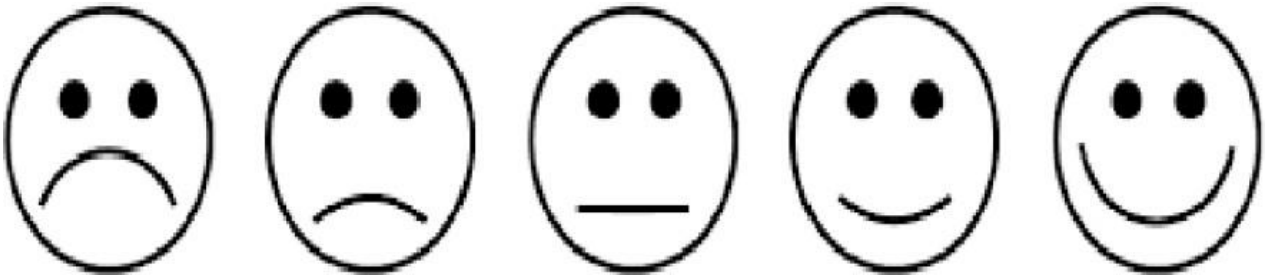


Dislike Very Much	Dislike	Neither Like nor Dislike	Like	Like Very Much
☐	☐	☐	☐	☐

Next

Please take another bite from the slice of the bread marked BC111.

How much do you like or dislike the flavour/taste of bread BC111?



Dislike Very Much	Dislike	Neither Like nor Dislike	Like	Like Very Much
☐	☐	☐	☐	☐

Next

Anything that you really like about the bread marked BC111?

Next

Anything that you really dislike about the bread marked BC111?

Next

Please drink some water before starting the next section.

Which one of the two breads that you tasted do you prefer?

BC111

BC222

Next

Please comment on why you prefer this bread.

Please respond to the following statements.
Each time choose an answer, based on your first impression. There are no right or wrong answers, only your personal opinion counts.

New food eating experiences are important for me.

I am afraid to eat things I have never had before.

I don't trust new foods.

New foods mean an adventure for me.

I like to challenge myself by trying new foods.

I am willing to try foods from different cultures.

Foods from other cultures look weird to eat.

Foods that look strange scare me.

If I don't know what is in a food I won't try it.

It is exciting to try new foods when travelling.

Disagree Strongly	Disagree moderately	Disagree slightly	Neither disagree nor agree	Agree slightly	Agree moderately	Agree strongly

How often do you eat bread?

- Never
- 1-4 times a month
- Several times a week
- Daily
- Several times a day

Next

Please select your gender.

- F
- M
- O

Next

What year were you born in? (e.g. 1994)

Thank you for sharing your opinion about the bread.

We would like to **send you a voucher by email** to spend at Pick 'n Pay. Please write your email address for the purpose.
Note that we will **not use your email address for any other purpose.**

SENSORY IDENTITY

your partner for sensory & consumer testing

A BUSINESS UNIT OF ENTERPRISES UNIVERSITY OF PRETORIA (PTY) LTD

Thanks for completing this test!

Finished

Appendix 10.5: Reasons why participants expect to not like the unfamiliar foods

Reason provided for why the participant expect to not like…				
OFSP bread	**porridge/pap made from sorghum**	**pasta made from bean flour**	**biscuits made from sorghum flour**	**snacks made from legume flour**
I don't eat fruit nor vegetables	I think the texture would put me off	Don't like beans	Taste	Never tasted them
Not really, just sounds odd and suspiciously healthy	Haven't tried it	Personally extreme dislike for beans flavour and texture	I don't even like mabele pap	Don't know product taste
The colour and taste	I expect it to be a bit coarse	Beans irritate my bowls	I expect the texture to be somewhat undesirable	Do not eat beans
I do not like orange as a whole	If it tastes like Matabell, I would not like it. If the profile is similar to maize pap	I do not like beans	Sorghum is a bit sour I guess.so I wouldn't want to taste something that is sour	Beans irritate my bowls
Hate sweet potato	It doesn't taste nice	The beany flavour will be a disadvantage. I wouldn't like the texture	They have a bitter taste	I do belch a lot after eating beans so I wouldn't incline to bean products
I don't want to taste a vegetable in my bread, it must be light wheat	Dislike the taste	I'm not really a fan of beans.	The sensory attributes of biscuits made from sorghum flour will most likely be inferior to the one made from wheat flour.	Perhaps the texture.
I don't generally like sweet potato (I'll eat it but it is not my first choice) so i don't think that I would enjoy sweet potato bread unless it is a more subtle flavour	I don't like the taste or texture of sorghum	Different texture to wheat pasta	Taste would not be as pleasant despite the nutritional benefits.	Beans does not taste nice
I don't like sweet potatoes	I'm more used to maize meal. It is more likely I will not enjoy the taste	The texture might be tough, which I dislike	I do not like the texture and smell of sorghum based products	Cannot imagine it to taste nice
Sweet potato does not taste nice and most breads with non-flour ingredients does not taste nice.	The taste	different flavour profile	I had too much sorghum based food when I was young	I just can't imagine myself eating bean puff snacks

Reason provided for why the participant expect to not like…				
OFSP bread	**porridge/pap made from sorghum**	**pasta made from bean flour**	**biscuits made from sorghum flour**	**snacks made from legume flour**
I don't like the taste of sweet potato.	Because I generally do not like pap so much whether it is made from maize or sorghum.	The sensory properties of pasta made from legume will not be as good as the one made from wheat. The absence of gluten in the former together with the presence of beans flavour will make legume pasta undesirable sensory-wise.	I would not like the sour taste of sorghum on a type of snack I really enjoy. I prefer sorghum pap.	I just don't like puffed snacks overall
The colour is off and the taste too	I do not really enjoy Matabella, which is also made of sorghum because of the rough texture	I believe the taste would not be as pleasant to the one made from wheat	I think it would have an aftertaste.	I am not familiar with them and I expect not to like them.
I expect it to be dense and starchy	It doesn't taste delicious at all, unlike the maize porridge.	Beans taste and texture are not nice. Also not sure of the economics of beans vs wheat. Bean flour should cost a lot more to produce.	I do not like the taste of sorghum.	I think the taste would not be that much desirable to me.
I don't think that it will taste nice	It has a very astringent and characteristic taste and texture that I will not like	I eat a high fibre diet already so the bean pasta isn't necessarily needed in my diet and I enjoy the texture of regular pasta.	Sorghum triggers my ulcers	It just sounds weird
I can’t eat oranges and potatoes at the same time	I do not like any porridge	I do not like the taste of beans	Dislike sorghum taste.	Can’t picture the taste to be the same or enjoyable.
I do not eat sweet potato	I do not like the texture and smell of sorghum based products	Texture might be bad and weird taste	Well I just can’t imagine it. I think a few other ingredients will have to be added as the taste will not really be as… “Sweet” (neutral) for wheat as sorghum will be a bit… bitter (dry).	The thought that chips being made from a bean is not so appealing
I do not like sweet things	It's usually a bit sour and bitter	had zucchini noodles before and did not enjoy	I know how sorghum tastes like and I don't think I will like my biscuits tasting like that.	It just does not sound appetisingly
I absolutely dislike sweet potato	I had too much of it when I was younger	I think it would have a stronger taste than pasta and perhaps a different texture.	I don't like how sorghum tastes like. So now I can’t imagine sorghum in biscuits	They might be tasteless

Reason provided for why the participant expect to not like…				
OFSP bread	**porridge/pap made from sorghum**	**pasta made from bean flour**	**biscuits made from sorghum flour**	**snacks made from legume flour**
not the traditional ingredient to be used and I am a picky eater	I expect that the texture will not be very appealing on a sensory basis	new, healthier variants of pasta are generally not enjoyable	Mabele taste horrible as they are, I can't imagine biscuits made of them.	I don't think I will like the taste
When I eat bread I like to have it with something salty, e.g. Butter, fish paste etc. The combination of orange fleshed sweet potato sounds interesting however I'm not sure how the implementation would go, considering I'm not really a fan of sweet potatoes.	The porridge is too dull and bitter for me	I'm assuming it won't taste as good. I love the regular pasta	I don't like sorghum	Does not sound appetizing
Dislike sweet potatoes	I have never tasted pap made from sorghum flour. I have, however, raw sorghum and slightly like it. But definitely not pap made from sorghum, I don't think I would like it is taste.	I don't like beans.	In my home, we are used to sorghum being sour. The thought is unpleasant.	I think that the snacks being made from bean flour would take away the original taste of the snack as compared to when it's made from maize.
I fear my bread would have a rather sweet taste to it , instead of it being neutral	I have tasted it before and I did not like it	bean flour is something I am not familiar with	Generally I do not like products made from sorghum	Taste is important and what if they don't taste like the regular cheese curls I am used to
I don't like sweet potatoes. I'm afraid I'll be able to taste it in the bread	I do not like the taste of sorghum.	I'm quite undecided on how they would taste as I'm not a big fan of beans, I only consume baked beans.	As already mentioned sorghum products do not taste nice and make my stomach sore.	I feel like they wouldn't taste nicer
I do not like sweet potato	It triggers my ulcers	Less neutral in taste. Would think that it is perhaps not suitable for all pasta dishes.	I do not enjoy biscuits already because of the sweetness so I am working under the assumption that my feelings about them would be the same.	I like beans but I just can't imagine the taste of puffs made from bean flour.

Reason provided for why the participant expect to not like…				
OFSP bread	**porridge/pap made from sorghum**	**pasta made from bean flour**	**biscuits made from sorghum flour**	**snacks made from legume flour**
I don't enjoy sweet potato	I do not like sorghum. It has a weird taste.	Have had it. The texture is not particularly desirable.	After completing the module VDS 413 some of the groups made biscuits containing sorghum flour and I found the taste and texture rather unpleasant	I am not sure which beans in specific, but personally I would not be willing because the beans may alter the taste of the original. Another thing is that, I personally- andante people I know, normally have loose stool after eating bean products due to their fibre content- hence that's another concern I have.
I am not a fan of sweet potato, I do not like the taste	It is too heavy for a porridge and sometimes can be too sweet	It would depend on the taste, if the taste is close to normal pasta, knowing that it's healthier than normal pasta I would go for it, but if it tastes taste totally different from normal pasta, then I would not purchase it.	Sorghum takes long to cook because it has to be put on low heat for it to be thoroughly enjoyed, so if it is made into a biscuit it would to some extent be raw and hard to chew	I do not think cheese puffs made from beans would taste good.
I prefer normal bread	I've previously tasted other products made from sorghum and I really didn't like it	I'm not a fan of beans	Sounds very weird	the texture
I do not like sweet potato that much, especially not on my bread	I generally don't like the sour taste and don't like the smell of it.	They usually have a weird aftertaste or almost sandy feeling in your mouth	I could make biscuits from oats. With sorghum it seems foreign	They would no longer have the same consistency as puffed snacks
I am not a fan of sweet potato	The taste is not nice.	Bean flour might make me gassy/fart a lot	I don't think it will taste the same anymore	It might not taste the same
It would not taste right	Mabela porridge has a slight bitter taste	I think that the taste of beans would be very over powering and take away from the pasta dish as a whole.	IT may taste dry and not sweet	They might have a bean after taste.
I do not imagine orange fleshed sweet potato would taste good on bread.	I don't like the texture	How will it taste	The texture needs to be smooth	I don't really get the taste it just doesn't make sense
I do not eat sweet potato	I don't like sorghum	I just think it wouldn't taste good	Having eaten mabele, I don't think I would like to taste sorghum based biscuits.	I do not like the taste of beans, therefore I don't believe I would enjoy

Reason provided for why the participant expect to not like…				
OFSP bread	**porridge/pap made from sorghum**	**pasta made from bean flour**	**biscuits made from sorghum flour**	**snacks made from legume flour**
				the taste of puffed snacks made from bean flour
I don't eat sweet potato in general	I've tasted products made from sorghum and I didn't like them	I have eaten lentil pasta before, it wasn't great, and the consistence and taste wasn't favourable so I'm not really in favour for it after all we all enjoy food that tastes good.	Sorghum is not sweet and it tastes grainy... I eat biscuits specifically for their sweet taste.	I doubt they will taste the same
I don't necessarily like sweet potato	might taste weird	I do not think the taste and texture would be the same as normal pasta	Having new is something I am not up too	I don't like beans
As long as the bread maintain its original colour I think it will be fine	The taste is horrible and it makes my stomach sore. Probably I am allergic.	It just seems like the bean pasta would be awful in taste	Because I would not know how would they taste. And sorghum is usually rough and not smooth.	texture would be a concern
It may have too much starch	It doesn't taste as good as the one made from maize	I'm scared it might slightly taste like beans, which would change how my pasta dishes taste overall.	I have sorghum (Mabele) at home and whilst it's a good porridge, I doubt it would be a good substitute for wheat flour. It is really an acquired taste and therefore, tolerable. However, I doubt I would enjoy sorghum flour cookies/ biscuits. Not do I think companies manufacturing their biscuit products with wheat flour would be willing to compromise as it may change the flavour of the wheat flour based cookies we are used to.	Unsure about taste.
I am not really a fan of sweet potatoes, although I wouldn't mind orange flesh.	It's not very sweet	Because I do not really like beans ,so anything with beans I dislike it	I don't really like the taste of sorghum, so I don't think I would enjoy biscuits made from sorghum.	I'm not sure how the snacks would taste due to the ingredients being used to make them.

Reason provided for why the participant expect to not like…				
OFSP bread	**porridge/pap made from sorghum**	**pasta made from bean flour**	**biscuits made from sorghum flour**	**snacks made from legume flour**
Bread contains carbohydrates which when digested because sugar. So I can't imagine the amount of sugar that one will be consuming if you add the mentioned ingredients.	I find mabele pap tasteless. But I however prefer mabele soft porridge with a dash of sugar and milk.	I do not really enjoy the taste of beans therefore I don't think I would like pasta made of bean flour	I can't wrap my head around biscuits made from mabele	Snacks made from beans just don't like they would have a good taste.
I dislike sweet potato	the after taste and the smell	I generally do not like beans	It won't taste the same as usual cookie	I think it would taste very differently as an alternative and end up not eating puff snacks if they were the only products offered on stores shelves made from bean flours
Because I'm allergic too sweet potato	It has a rough tasting texture.	The taste might be a bit odd.	I prefer sorghum when it's in porridge or pap and for cookies and biscuits I don't think I will enjoy it that much.	I don't know how the snacks will taste as well as the texture might not be to my liking
I don't think that sweet potato tastes great.	It does not taste very pleasant and I don't enjoy the smell of porridge made from sorghum.	I'm not a fan of beans, I dislike the texture of beans and I'm worried that the bean flour would create the same texture.	I've tasted sorghum before, I disliked it. It's unlikely I would choose biscuits made from it, unless you can't taste the sorghum flavour.	I think that the base taste of the puff and the flavouring may clash
I have had sweet potato rice cakes and didn't enjoy those	How it will look like plus taste. They say you eat with your eyes first	Unsure about taste.	I don't like the taste of sorghum	I'm not familiar with products made from bean four
I do not eat vegetables on an everyday basis, hence I wouldn't not like to eat bread with a vegetable	I generally don't enjoy sorghum products, so I don't think I'll like pap made from it, but I will not knock it till I've tried it	Because I have never had bean flour before	Simply because I have already associated, in my brain, the taste and texture of sorghum with a breakfast porridge (the runny kind). I cannot imagine enjoying that taste and texture in the solid form of a biscuit.	Bean flour is weird
I am not a fan of oranges and sweet potato I prefer it being boiled only. I wouldn't like bread with so many constituents	I have had it before, when I was really young. To me, it isn't too different from maize porridge so my feelings towards the two are more or less the same.	I would not want my pasta any different from the way it is now	I can't imagine it as a taste or final product	It won't taste the same

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the idea of flavoured bread is not appealing to me, it may alter the taste of the whole meal	It is to sour and makes me nauseas	Because I'm already used to eating pasta made from flour so having to change to one made from bean flour would truly change how i enjoy pasta. And I would also have to taste the pasta before	The colour and taste of the biscuit will most likely not be appealing and taste good	I like specific taste of the puffs I like wouldn't want it to change
I don't enjoy the taste of sweet potatoes.	There's no reason except it's personal preference	The idea of bean flour is weird	I've tasted sorghum porridge, not sure it would be as good in biscuits.	I already don't like puffed snacks, I bet I will hate the ones made of bean flower.
Am worried about how it taste	I am not a fan of porridge in general	It doesn't sound appealing	I have actually tried recipes with sorghum and didn't like the taste of the biscuits. They crumble and are not tasty	I do not want to snack on beans
I don't like sweet potato	I don't particularly like the sour taste.	I'm concerned about the extra flavour	I have already made an association, in my head, of sorghum with the texture of porridge (the more runny, breakfast porridge). I am finding it difficult to imagine that I would enjoy the texture and flavour of sorghum in a more compact solid form like a biscuit.	I am not a fan of beans
Because it's still bread	Used to maize porridge, but most my family members enjoy it	I do not think it will taste good	The texture might be slightly rougher than usual. The dough might not rise the same	I honestly don't think bean flours are the best option for a snack unless there is an innovative way to make them taste extremely good. They would have to prove that they are worthy of my money because to me snacks are more about taste and fun, and less about health. I honestly buy snacks for enjoyment
Because the bread and potato does not mix it better if the bread it on I own and the potatoes as well	I do not like the taste and sour smell it has	I do not like beans	I don't like the taste of mabele	Bean flours may change the texture

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It doesn't make sense to my brain	It is not tasty, the texture is rougher and the smell reminds me of African Beer. It doesn't look appetizing as well.	I do not like beans	I feel like the texture will be different.	I just don't like puffed snacks that much, so I wouldn't go out of my way to buy them
Bread and sweet potato doesn't seem like an interesting combo	Pap has a smooth texture to the tongue, and sorghum doesn't. I prefer smooth textured foods. And I think being comfortable with a certain taste would also influence my choice	Doesn't seem like it would taste and have the same texture	I do not think it would taste good	I do not like beans therefore snacks made from bean flour will not taste good
I do not like the taste of orange fleshed sweet potato. I do not think having it as an ingredient in bread would make it taste better.	I don't think it taste really nice, compared to the one made of maize.	I do not usually enjoy many types of beans	the texture of the sorghum would be a concern	I am allergic to beans
I do not like or eat sweet potato	I don't like the sour-like taste	I'm not sure if it tastes good	I don't think I would like how they taste since they would be made from beans	No
I'm very particular about the smell and taste of food, especially that which I am used to already.	I like plain pap more.	It doesn't make sense	Might affect overall taste of biscuits	I do not really like puffed snacks, i think i would not like it when made from bean flour
I don't like sweet potato.	Not used to the colour and taste. Sorghum porridge is usually eaten for breakfast, to replace maize porridge with it in terms of dinner would be rather unusual	I do not like beans, therefore I don't think pasta made from bean flour will taste good.	I'm allergic to sorghum	Cannot even imaging what it would look like and the texture of it.
The possible taste	I don't eat sorghum	I would have to taste it first. I do not particularly like beans, so the thought of my pasta tasting like beans does not sound delicious.	I am not a fan of sorghum.	Because beans isn't something I like to eat

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I don't think the taste of orange and sweet potato would be nice.	I don't like sorghum	The texture and aftertaste is unpleasant to me. I prefer hummus, chickpea flour, rice flour, rye or raw chickpeas (falafels).	I don't think it will taste good. I'd rather have flourless cookies	I expect the snacks to have a different taste and consequently to dislike its flavour.
I don't like sweet potatoes	I have eaten sorghum before and I did not like it.	Most beans do not work when combined with most ingredients needed to make pasta.	Not sure as how they would taste	I can't imagine ow chilli cheese curls would taste like when made from bean flours
I think I would have a problem with the texture	It tastes a bit bitter	I love eating the two separate as they both are sources of fibre	Sorghum can be sour	I cannot imagine snacks made of beans, never mind the taste. Will it go well with the different flavours because maize is tasteless on its own but beans has a certain taste?
I do not enjoy sweet potato at all, in fact I only ever tasted it once.	It tastes very sour.	I don't like beans	Sorghum tends to make things sour, and I don't like sour things.	Beans are not nice
I do not like sweet potatoes	I'm familiar with it... don't like the taste	I have never tasted pasta made from beans but the general trend with food is that substitutes don't taste as good as the original (even if on a molecular/cellular level the substitutes are identical)	I don't like sorghum	The taste would be different It's a snack taste is everything
I do not like sweet potatoes, and I'm ketogenic the lesser carbohydrate the better	I don't necessarily enjoy the different texture that sorghum has.	I think it will have an unusual smell if it is anything like soya bean flour. I really don't like the smell of soya bean flour	I do not know how sorghum would taste after being baked	Never tasted it
Different from the norm	I genuinely just don't like porridge so chances of liking porridge made from sorghum a slim.	Not a fan of beans.	Things made with sorghum have a sour taste	I think the taste and texture of bean puffs would be much different. The bean puffs I would expect to be dense and not as light as the maize puffs.

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I do not like the taste and texture of sweet potato	I think sorghum is for making beer	The unknown base. I think the texture wouldn't be as palatable as I am used to. The consistency of wheat pasta is what makes it enjoyable and legumes are a lot different. I think even the cooking time would be longer given the properties of legumes.	Not a fan of sorghum	The taste would be different
Does not sound appetizing	I do not like the taste and smell of sorghum.	I don't like the flavour of beans	Would be concerned about the taste	Taste and weight in the digestive tract
Sweet potato is not nice unless it is mixed with mush mellows	I've tried it before and I hated the taste	I dislike beans and it would just be wrong	I can't imagine myself enjoying it	Don't like beans, would not be the same texture or taste.
I'm not a fan of sweet potato.	I don't like sorghum	The idea of a flour made from beans is strange to me....it would take me time to get used to.	I do not think that the taste will be nice	It is an unusual idea...it would take time to get used to it.
The taste may be weird and also the ability to stay fresh for long may be affected with the addition of the new ingredient.	It's sour	Would it taste like beans?	I do not like how it tastes generally so I'd imagine the taste wouldn't appeal to me	There is something inherent in maize that makes it different to me I don't think it can be replicated
I don't like sweet potatoes	The texture of the pap will be too smooth and the Colour won't be appealing	Beany flavour, textural differences	I have had sorghum biscuits before and they were tasteless and very dry. Left a bad aftertaste as well	
Sweet potato	Taste.	Don't like beans	It will taste healthy. I don't like a healthy taste with biscuits, I'd like it to be sugary and buttery with same taste of flower.	
It will probably be expensive	No		I've had sorghum biscuits and the texture was very dry	
The bread would be too sweet.	I do not like sorghum.		Different taste	

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I'd be concerned that it would look orange.	The taste of the porridge might be different to what I am normally used to. And that will be slightly discouraging to purchase.		sorghum has a distinct taste and texture that I would not enjoy in biscuits	
Sweet potato taste horrible imagine now having it in bread	I just prefer maize.		Sorghum pap is very tasty and grainy. So I believe biscuits would have a bad taste due to the grains of the sorghum.	
Wouldn't that make the bread sweet? I don't like the flesh of any potato including sweet potato	I do not like porridge in general, I know sorghum has a bitter taste so I don't think I would enjoy sorghum porridge		I can't imagine the taste of it and if sorghum is closely related to mabele, that's a weird taste to have in biscuits	
I like plain bread. DO not add or take away anything from bread, the plainer the better	I don't believe the grain will result in similar textures given by maize		I prefer biscuits made from wheat.	
I don't think sweet potato would be a good ingredient for bread	I like the porridge made from sorghum but the pap made from sorghum, I don't like it because it taste differently and I am used to maize pap.		I don't like them	
Too much sugar in a bread	It tastes bad			
I don't like the after taste and the texture	I don't enjoy it		I don't think they would taste nice	
I don't eat sweet potato	Taste		I think they won't taste very nice	
I don't enjoy the taste of sweet potato	It causes constipation.		I don't really like biscuits in general	
I wouldn't like my bread to taste like sweet potato	It contains those particles of roughage therefore unless refined it will never be as soft as maize pap		Guess it's a mental picture. Would like to try, but for some reason don't think it's going to be as good.	

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I prefer plain bread	I do not like the consistently		Because I already don't like normal biscuits so I think I won't like the taste of biscuits made from sorghum	
Wouldn't be accustomed to the taste	Not a big fan of porridge.		I don't have a sweet tooth, hence I only have cookies once or almost never	
Not a fan of sweet potato. It'd ruin the bread for me	Sorghum tastes and is more nutritious than pap, so I like sorghum more than pap.		Tastes off	
I would not expect the bread to have a long shelf life but as for the taste, is would expect it to taste nice	I couldn't consume it at a very young age. It is not about allergies, but I just didn't like the taste.		It probably won't have the same taste and that's the only reason I eat biscuits They are seen as a luxury snack and if they don't taste as good then there's no point in eating it	
I would expect that it would not have a long shelf life	The scent us too strong (offensive) for me.		I do not like the taste of sorghum	
I generally don't like sweet potato. I won't like the bread containing orange fleshed sweet potato			Sorghum taste is very potent and overpowering	
Flavoured bread does not sound nice			Biscuits are not my go to food. I indulge once in a while	
Taste may be too savoury to pair with items such as eggs, peanut butter and jam, cheese			The taste would be different	
Won't it be sweet?			This could be because I have not tasted biscuits made it from sorghum. This would be purely based on how the biscuits would taste like.	
Don’t think orange belongs in bread			sorghum does not taste good	

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It's out of the ordinary and I'm not sure if it's palatable.			Because sorghum is has a rough texture so I think the biscuits will not taste as good as the ones made from wheat flour?	
The texture of sweet potato is not desirable.			I have tried baking bread with sorghum flour and the taste was not enjoyable. I can imagine that cookies might have that same taste	
I think the bread will taste differently			The taste	
I don't like eating sweet potatoes in any other form but it being mashed			I do not think that would taste good	
I expect it would not taste like normal bread of feel like normal bread unless additives and colouring is used			I feel like it wouldn't bring out the other flavours like the ginger, lemon etc. as well as wheat flour	
Sweet potato does not taste good			The smell of fermented sorghum is not pleasant.	
I do not enjoy sweet potato in general so having it in my bread would not be enjoyable for me.			I don't think they would taste nice	
I prefer to eat sweet potatoes peeled and boiled or baked. I prefer most food without oranges. But I do like that it's orange season now. I prefer them all separate.			I do not like the texture and taste of mabele	

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I personally love my bread plain. If I feel like anything flavored, then I'd rather eat cake or muffins.				
Orange and sweet potato do not sound like an enjoyable combination.				
Don't think the combination of the ingredients will be working well together.				
I do not know what orange flesh sweet potato is.				
I don’t like sweet potato				
Because it will contain sweet potato and I don’t eat sweet potatoes				
it does not taste nice to me				
I do not like grainy bread or any fruit in my food/solids				
The assumed taste				
I don't like orange as a flavour and as a fruit				
I do not like sweet potatoes				
I don't like sweet potatoes. I don't think If it will affect the taste of it				

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I like orange and sweet potato as it is. Anything that contains these is not appetising for me because it ruins the taste				
The potatoes will make the bread sweet and I am not a big fan of sweet breads or sweet things in general.				
I do not eat sweet potatoes				
I'm not a fan of the taste sweet potatoes				
The taste would bother me				
I personally do not like sweet potatoes.				
I don't like sweet potato				
I am not a fan of sweet potato				
I dislike sweet potato				