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The effects of rational and emotional sustainability appeals to consumers' sensory perceptions and emotions

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Extrinsic cues are widely used by researchers to develop consumers' perceptions of food. This study aimed to investigate how consumer perceptions and emotional responses to roti prepared by replacing the proportion of wheat flour with wheat bran (an agriculture by-product) were affected by rational and emotional sustainability appeals. The experimental design included three evaluation sessions. Four different samples of roti were developed from four different bran-wheat proportions. Results showed that rational and emotional sustainability appeals affected the sensory perception of 10–90% and 20–80% of bran-wheat roti samples. However, sustainability appeal had no significant effect on the 30–70% bran-wheat roti sample. Results also show that responses under blind condition were associated with negative emotions, while responses under sustainability appeals were associated with positive emotions. Rational sustainability appeal was heavily associated with positive emotions as compared to emotional appeal.

KEYWORDS

traditional, sustainability, bran, by-product, rational appeal

1 Introduction

Wheat bran is a by-product produced during the dry milling of (*Triticum aestivum* L.) wheat into flour. It is an economical ingredient with several health benefits, but its use in the human diet is limited because of its digestion and absorption difficulties, flavor and appearance. However an appropriate amount of fiber is good for intestinal health. Wheat grain comprises 14.5–25% bran (Das Neves et al., 2006; Xie et al., 2008), but only 10% of it is used in cereals and baked items as a source of dietary fiber (Rahman et al., 2017). While 90% of bran, is wasted by millers because of its high transportation expenses (Rahman et al., 2017), used as animal feed or for biocomposite production in the biomedical industry (Dungani et al., 2016).

People consider it inappropriate to include it in their diet because of its indigestion qualities (Sozer et al., 2014), taste and appearance differences (Heiniö et al., 2016; Stanyon and Costello, 1990). Sozer et al. (2014) found that addition of wheat bran reduced contents of digestible starch in biscuits. Heiniö et al. (2016) found that the addition of wheat bran darkened the color and increased bitterness in cereal foods.

However, the micronized form of bran is considered suitable for consumption in the human diet. Research shows that micronized bran could be used as a food ingredient, and its addition to food could improve the nutritional potential of food products (Hemery et al., 2011). The role and use of agriculture by-products are gaining popularity because of their contribution to food sustainability. Approximately 14 % of the world's food is wasted annually from harvest to retail market (FAO, 2019), and 17 % of food is

wasted at retail and consumption levels (UNEP, 2021). The highest food loss (approximately 21%) occurs in Central and South Asia (FAO, 2019).

Natural disasters, production losses and personal preferences are among the factors which cause food losses and wastage. For example, fruit by products such as peels, trimmings, bagasse, bran, seeds, stems and shells account for more than 50% of fresh fruits (Ayala-Zavala et al., 2011). A fifth part of edible food such as food by-product is wasted due to its surface blemishes, unique coloration and unfamiliar shapes.

Therefore, food scientists and researchers are working hard to find its suitability for the human diet. Number of studies have been carried out to determine its suitability for the human diet (Gómez et al., 2011; Lee et al., 2010; García et al., 2002; Zhang and Moore, 1997). Apart from suitability, commercialization of by-products is also under consideration. A number of studies are being carried out to understand how to commercialize these food products successfully because food products prepared from food by-products exhibit low sensory qualities (Gómez et al., 2011; Singh et al., 2012; Zhang and Moore, 1999).

Literature confirms that effective marketing communication could enhance the acceptance of upcycled products (Ghazanfar et al., 2022; Zhang et al., 2021; Bhatt et al., 2020). The effects of both intrinsic and extrinsic properties in the acceptance of food by-products are under investigation. Few studies have investigated the role of extrinsic properties (message) in food by-product acceptance as an ingredient. Literature shows that health (Fernqvist and Ekelund, 2014; Mora et al., 2020), organic (Ekelund et al., 2007), local (Januszewska et al., 2013), and environmental claims (Henchion et al., 2016) could enhance acceptance of upcycled products.

Environmental claims are widely studied to assess the acceptance and willingness to pay for upcycled food (Ammann et al., 2024; Giezenaar et al., 2024; Ghazanfar et al., 2022; Henchion et al., 2016; Bhatt et al., 2020). However, the impact of environmental claims on sensory perceptions and investigated the impact of sustainability claims on consumers' sensory perceptions or emotions. Giannoutsos et al. (2023) studied the effect of sustainable sensory packaging on sensory perceptions of rusk, and they found sensory perceptions of rusk were heavily driven by positive emotions due to sustainable packaging. Ford et al. (2024) studied the effect of environmental information on consumer liking and emotional responses toward conventional and hypothetical precision fermented yoghurt, and found that environmental information slightly improves liking and emotional responses for precision fermented yoghurt however decrease liking for conventional yogurt.

Mora et al. (2020) studied the impact of sustainability, local, and health claims on dip sauce liking (i.e., color, taste, density, and flavor) prepared from vegetables by-products. However their results showed that sensory perceptions were not affected by the sustainability claim. Similarly Erhard et al. (2024) found that sustainability claim adversely affects the taste perceptions of consumers seeking hedonic benefits from food.

However, these few studies are not enough to conclude the role of sustainability claims in shaping or enhancing sensory perceptions and emotions. Mora et al. (2020) made a dip from vegetable by-products and tagged it with "made using food by-products," and asked respondents to evaluate its sensory characteristics after tasting it. Mora et al. (2020) found the insignificant effect of the sustainability message.

This study hypothesize that the presentation of the message plays an important role in the persuasiveness of the message. Literature suggests that an appropriate message focusing on the product could enhance new product acceptance (Krishnan and Jain, 2006). Presenting a message by creating the right appeal could enhance the effectiveness of the message. The nature of the appeal used to deliver messages could play an essential role in improving the effectiveness of persuasion attempts. Copeland (1924) proposed that consumers often purchase products for two reasons—rational or emotional. Marketing communication aligned with consumer purchasing goals could enhance communication effectiveness. Therefore, this research aims to analyze the effects of the two sustainability appeals (rational and emotional) on consumers' sensorial liking (taste, color, and aroma) and emotions toward "Roti" prepared from wheat bran.

Rational appeal provides consumers with logical arguments, why product is valuable to them. Emotional appeal stimulates negative or positive feelings associated with the product or supports a cause to influence consumer purchase decisions (Armstrong et al., 2014). Designing the right appeal is essential for sensory and emotional acceptance of upcycled products because food prepared from by-products exhibits low sensory qualities (Gómez et al., 2011; Singh et al., 2012; Zhang and Moore, 1999). Weak sensory characteristics might restrict the use of by-products in the human diet. However, sustainability claims could affect consumer sensory perceptions and emotions (Giannoutsos et al., 2023). Both rational and emotional appeals have been widely used by researchers and marketers to increase product acceptability. A number of studies have drawn comparisons to understand their effectiveness. The literature shows that rational appeal develops a positive product attitude than emotional appeal (Heath et al., 2009; Rizwan et al., 2013). However, literature also supports that emotional appeals evoke favorable emotions; consumer associates these emotions with the advertised product, and this association helps to enhance product acceptance (Metha and Purvis, 2006; Yoo and Deborah, 2005).

However, creating a suitable appeal to promote sustainability is under investigation. To the best of our knowledge, only Bhatt et al. (2020) tested the effects of emotional and rational sustainability appeals on willingness to pay for food prepared from food by-products. Their results showed that rational appeal is more effective in increasing willingness to pay than emotional appeal. However, their research was on visual stimuli and they did not study the effects of sustainability appeals on consumer sensory perceptions. Testing of a real stimulus in food is better to understand consumer acceptance.

The literature also confirms that upcycled food lacks sensory qualities. So, the analysis of the effects of the using different sustainability appeals could lead to a better understanding of upcycled food acceptance and willingness to pay.

To the best of our knowledge, no research study has investigated how these two different sustainability appeals affect sensory perceptions and emotions toward food prepared from food by-products.

Therefore, the present research study will investigate the influence of two different appeals, i.e., emotional and rational sustainability appeals on sensory perceptions and emotions for traditional product "roti."

Traditional products could be more vulnerable to ingredient change. Kühne et al. (2010) suggested "preservation of the traditional state" of the food as a "prerequisite" for innovation in

traditional food recipes and products. However, sustainability claims could help to overcome consumers' reservations about change. Giannoutsos et al. (2023) found that information about sustainable packaging affects food acceptance and emotional responses toward traditional Greek rusks (paximathi). Roti (chapati) is a flat round bread, used as a staple food in the Indian subcontinent. It is popular in many South Asian countries including Pakistan, India, Singapore, Sri Lanka, Bangladesh, Nepal, Thailand, Maldives, Jamaica, Myanmar, Indonesia, Malaysia, and many more. It is made from a combination of water and wheat flour, which are combined to make dough (Haridas Rao and Sai Manohar, 2003). However, wheat production is not sufficient to meet the daily demand of South Asian people, whose staple food is roti. In South Asian countries, wheat is the main component of the milling and baking industries.

The increase in population and natural disasters has badly affected wheat production, which fails to meet dietary needs. Bran can substitute a proportion of wheat in roti making. Bran is an economic agriculture by-product with multiple nutritional values, i.e., proteins, fats, carbohydrates, minerals, vitamins, antioxidants, and phenolic compounds. The use of bran in daily diet may help to maintain the performance of the gut, prolong satiety, and regulate appetite (Wang et al., 2023).

However, its replacement as a proportion of wheat flour in roti might disturb its sensory characteristics. Literature confirms that consumers reject new food products that they recognize to be unpalatable, regardless of health claims (Lyly et al., 2007).

So, the objectives of this study are to investigate the effects of two different sustainability appeals, i.e., emotional and rational appeals on consumer sensory perceptions and emotional responses toward different samples of roti prepared from various wheat and bran proportions.

2 Methodology

2.1 Experimental design section

Two experiments were designed for this research study. Experiment 1 was conducted to analyze the sensory characteristics of wheat-made roti (with any addition of bran), which would help to compare the sensory attributes of wheat-made roti and wheat-bran roti (Experiment 2) for readers who have not tasted or seen roti before.

Experiment 2 was conducted to analyze the effects of two different sustainability message appeals on consumer sensory perceptions and emotions for wheat-bran roti. To test the effects of two different message appeals in Experiment 2, a pilot study was conducted in which two different electronic videos with two different sustainability appeals (emotional and rational) were made and tested for further experiment.

2.2 Experiment 1

2.2.1 Participants

Forty-five participants (men = 40%, age = 17 ~ 40 years; women = 60%, age = 18 ~ 45) participated in this experiment. Experiment conducted in June 2023 and it took 30 days to carry out

this experiment. Participants were asked to taste roti prepared from whole-wheat flour. The purpose of this experiment was to assess participants' sensory perceptions and emotional responses toward wheat-made roti.

The Experiment 1 was conducted to analyze the sensory characteristics of wheat-made roti, which would help to compare the sensory attributes of wheat-made roti and wheat-bran roti (Experiment 2) for readers who have not tasted or seen roti before. After tasting the roti, participants evaluated the roti based on its sensory characteristics (liking, taste, texture, and color) and expressed their emotional responses. A monadic sample presentation method was used to assess sensory perceptions and emotional responses.

2.2.2 Response measures

Different 9 points hedonic scales were used to analyze liking (1 = extremely dislike, 5 = neither dislike nor like, 9 = extremely like), color (1 = too much light brown, 5 = moderate brown, 9 = too much dark brown), texture (1 = granular, 5 = just about right, 9 = smooth), and taste (1 = not worth tasting, 5 = just about right, 9 = worth tasting).

Next, emotional associations with roti were evaluated on the valence × arousal circumplex-inspired emotion questionnaire (CEQ) (Jaeger et al., 2020). The respondents were asked to answer, "How do you feel" from 12 pairs of emotions listed in Table 1. To increase stimulus discrimination, the CEQ was implemented as a (CATA) questionnaire (Jaeger et al., 2021).

2.2.3 Data analysis

One-way Analysis of Variance (ANOVA) and Tukey's HSD for *post hoc* tests were used to assess differences in mean values at a 5% significance level $\alpha = 0.05$ ($p \leq 0.05$).

Correspondence analysis (CA) and Principal Component Analysis (PCA) studied relationships between selected emotions under different conditions. Cochran's Q test analyzed the differences between different frequencies of cited emotions. All statistical analyses were performed using XLSTAT software (Version, 2018.1., Addinsoft).

2.2.4 Results

The results of experiment 1 show that respondents expressed their liking ($M = 8.00$; $SD = 1.55$) for wheat-made roti, found it smooth ($M = 6.75$; $SD = 1.58$), tasty ($M = 8.13$; $SD = 1.05$) and moderate brownish in color ($M = 4.88$; $SD = 1.70$).

2.3 Pilot study

Two videos with different appeals were designed for this study. An animated video focusing on food waste and hunger facts was designed to create rational appeal. The emotional video involved human (adults and children) actors. The video was voice-over with the message "In every 5 s, a child dies because of hunger while millions of pounds of food are wasted worldwide." The methods used for designing emotional and rational appeal videos are in line with (Bhatt et al., 2020).

2.3.1 Pilot study results

The study used Paired-sample t-tests to examine whether respondents perceived the difference between appeals presented in the videos. Forty participants participated in this experiment. Each

TABLE 1 Citation frequency (0 to 100) for the 12-word pairs of emotions under different evaluation conditions.

Emotion-based terms	BC	RSA	ESA
Active/alert ¹	22.4 ^{ab}	55.1 ^b	43.3 ^b
Energetic/excited ¹	8.3 ^a	37.2 ^b	69.2 ^c
Enthusiastic/inspired ¹	8.8 ^a	64.1 ^c	40.8 ^b
Happy/satisfied ¹	1.3 ^a	44.9 ^b	31.6 ^b
Secure/at ease ¹	9.2 ^a	48.7 ^b	31.6 ^b
Relaxed/calm ¹	1.3 ^a	9.0 ^a	18.4 ^{ab}
Passive/quiet ¹	20.5 ^{ab}	2.5 ^a	6.8 ^a
Dull/bored ¹	9.2 ^b	3.8 ^a	0.00 ^a
Blue/uninspired ¹	39.5 ^b	3.8 ^a	2.6 ^a
Unhappy/dissatisfied ¹	2.6 ^a	2.5 ^a	1.3 ^a
Tense/bothered ¹	3.9 ^a	2.6 ^a	5.3 ^a
Jittery/nervous ¹	30.3 ^b	3.8 ^a	3.9 ^a
Restrained ²	9.2 ^a	32.1 ^b	25.0 ^{ab}
Prudent ²	0.00 ^a	52.6 ^{bc}	59.1 ^{bc}
Indifferent ²	35.5 ^b	7.7 ^a	3.9 ^a

Cochran's Q test was used to compare samples.

Same superscript letters of columns indicate statistically insignificant differences ($p \leq 0.05$). Pairwise Critical difference (Sheskin) procedure was used to conduct pairwise comparison.

*BC, Blind Condition; ESA, Emotional sustainability appeal; RSA, Rational sustainability appeal.

¹Emotions based on CEQ questionnaire.

²Consumers generated emotions.

participant was shown one video. After watching rational video, participants were asked to answer "Does this video appeal more to your rational or emotional side?"; (1 = emotional, 9 = rational) and after watching emotional video, participants were asked to answer "Does this video appeal more to your heart or your mind?"; (1 = mind, 9 = heart); (Bhatt et al., 2020).

Paired-sample *t*-tests were used to analyze whether respondents perceived the difference between appeals. The results of the test showed that respondents rated the rational video to be the more rational [$t(39) = 13.4, p < 0.05$; $M_{emotional} = 4.62, M_{rational} = 8.02$] than emotional video. Similarly, participants rated emotional video to be more emotional [$t(39) = 17.5, p < 0.05$; $M_{emotional} = 8.05, M_{rational} = 4.40$] than rational video.

2.4 Experiment 2

2.4.1 Participants

One hundred and eighty ($N = 180$) participants (men = 70%, age = 19 ~ 52 years; women = 30%, age = 20 ~ 45 years) participated in the experiment. 90% of participants claimed that they eat wheat roti thrice a day and 20% of participants eat twice a day. The experiment started in June 2023, and took 90 days to carry out.

The test was conducted at an institutional central location test (CLT) facility, where participants ($n = 180$) tasted wheat-bran roti prepared from three different bran-wheat mixtures. Respondents evaluated roti on its sensory attributes (taste, texture, color), and also expressed their emotional responses. A monadic sample presentation was used to assess sensory perceptions and emotional responses. A between-subjects research design was used for this study and each respondent was exposed to one of three designed

experimental conditions; (1) Blind Condition (BC) (without sustainability claim), (2) Rational Sustainability Appeal (RSA), and (3) Emotional Sustainability Appeal (ESA). Under BC, no information was provided to participants other than ingredients. Participants were asked to taste roti prepared from one of three bran-wheat mixtures. While under-informed conditions, participants first viewed one of the two designed videos. After watching the video, the participants were explained about the contents of the video to make sure that they understood the message.

After discussion, the respondents were given an attention check question, in which they inquired about facts and figures (presented in the video) to ensure that they had watched the video attentively (Abbey and Meloy, 2017).

After the attention check question, they were instructed to taste only one roti prepared from one of three bran-wheat mixtures in random order. The participants were allowed to take as much quantity (of only selected roti) as they wanted. The roti is prepared from three bran-wheat mixtures were tagged with unique numbers (reflecting mixture proportion).

After confirmation of their attention, the participants were presented with a questionnaire and instructed to mention the tag number (mentioned with roti) on the questionnaire.

After that, they were asked to evaluate roti based on its sensory qualities and were requested to choose suitable emotions from a given list of emotions. After that respondents were asked to mention their age and gender.

2.4.2 Product preparation

A roti was prepared from three different bran-wheat mixtures. The measurements for wheat and bran mixture were made according to the formulation of the AACC method (American Association of

TABLE 2 Effect of Wheat bran addition on the sensory profile of roti.

Bran%	Blind condition			Rational sustainability appeal			Emotional sustainability appeal					
	Texture	Color	Taste	Liking	Texture	Color	Taste	Liking	Texture	Color	Taste	Liking
10	5.52 ^{cd}	5.38 ^a	6.23 ^{abc}	6.39 ^{abc}	6.00 ^d	4.38 ^a	8.00 ^c	7.52 ^c	6.40 ^f	5.33 ^a	7.66 ^{ab}	6.61 ^{bc}
20	4.28 ^{abc}	4.84 ^a	5.14 ^a	4.90 ^{ab}	5.52 ^{bcd}	5.00 ^a	6.04 ^{ab}	7.04 ^c	5.00 ^{bcd}	5.23 ^a	5.61 ^{ab}	6.61 ^{bc}
30	3.52 ^{ab}	4.95 ^a	4.90 ^a	4.94 ^a	3.38 ^a	5.19 ^a	5.04 ^a	5.71 ^{abc}	3.60 ^{ab}	4.80 ^a	5.14 ^a	5.09 ^{ab}

*Numbers with different superscripts letters in a column show that they are significantly ($p \leq 0.05$) different according to Tukey's Range Test. Score sharing nor same letters are significantly different ($p \leq 0.05$).

Cereal Chemists, 2000) (Table 2). Wheat flour in the formulation was replaced with 0, 10, 20, and 30 g/100 g wheat bran.

Micronized wheat bran of 20 μm was used for the experiment because it helps to make smooth dough (control grittiness) and boosts anti-hyperlipidemic and hepatoprotective characteristics that protect humans against chronic diseases and metabolic syndrome abnormalities (Junejo et al., 2019). Three different types of dough were prepared from three different bran-wheat mixtures. Each dough was divided into 20-gram equal pieces (called "pedda"), to make roti of standardized thickness of 1/8th of an inch. The traditional cooking method was used to cook roti. Roti was made on a traditional specialized pan called "Tawwa" 0.25 grams of pedda was first transformed into an even flat round wrap of 4 to 6 inches in diameter with the help of a rolling board and pin.

Then it heated on tawwa on medium heat for 25–30 s until bubbles started appearing on the top. At this point, we flipped the wrap to cook it from the other side, both sides were cooked for about 25–30 s until brown spots started to appear everywhere. After that, we shifted the roti directly to the flame with the help of a tong and let each side cook for 5 seconds before removing it from the flame.

2.4.3 Response measures

Different 9 points hedonic scales were used to analyze liking (1 = extremely dislike, 5 = neither dislike nor like, 9 = extremely like), color (1 = too much light brown, 5 = moderate brown, 9 = too much dark brown), texture (1 = granular, 5 = just about right, 9 = smooth), and taste (1 = not worth tasting, 5 = just about right, 9 = worth tasting). Next, emotional associations with roti were recorded on the valence \times arousal circumplex-inspired emotion questionnaire (CEQ) (Jaeger et al., 2020). The respondents were asked to answer, "How do you feel" from 12 pairs of emotions listed in Table 1. To increase stimulus discrimination, the CEQ was implemented as a check-all-that-apply (CATA) questionnaire (Jaeger et al., 2021). Three food specific emotions "Prudent," "Restrained," and "Indifferent" were added to the list by respondents.

2.4.4 Data analysis

One-way Analysis of Variance (ANOVA) and Tukey's HSD for *post hoc* tests were used to assess differences in mean values at 5% significance level $\alpha = 0.05$ ($p \leq 0.05$). Correspondence analysis (CA) and Principal Component Analysis (PCA) were used to examine relationships between selected emotions and different conditions. Cochran's Q test was carried out to highlight differences between the frequencies of selected emotions. All statistical analyses were performed using XLSTAT software (Version, 2018.1., Addinsoft).

2.4.5 Result

One-way ANOVA was conducted to determine differences between sensory perceptions under three different conditions, *post hoc* test was conducted using Tukey's HSD.

2.4.5.1 Consumer sensory perceptions under different evaluation conditions

The results of the liking and sensory evaluation are evaluated on a 9-point hedonic scale (Table 2).

2.4.5.2 Color

Results show insignificant differences in color between the three evaluation conditions. The results show that consumers found no visible differences in the colors of rotis prepared from three bran-wheat mixtures. The respondents found roti of moderate brown color between all three evaluation conditions.

2.4.5.3 Taste

There were significant differences in taste between the three evaluation conditions. Samples under both rational and emotional sustainability appeals received higher taste scores than the blind condition. The rational sustainability appeal received higher taste scores than the emotional sustainability appeal. The results show that respondents rated roti more tasteful than the blind condition, that confirms that sustainability appeals were successful in changing taste perceptions toward upcycled food.

2.4.5.4 Texture

Results show significant differences in texture between the three evaluation conditions. Respondents rated roti less granular after both emotional and rational appeals. Results confirm that sustainability appeals minimize the presence of granulars in roti by changing perceptions toward acceptable roti texture. Respondents in blind condition showed less favorable attitude by rated roti granular, however respondents under sustainability appeals showed more favorable attitude by rating roti less granular.

2.4.5.5 Liking

Results show significant liking differences between the three evaluation conditions. However, 10–90% and 20–80% bran-wheat roti

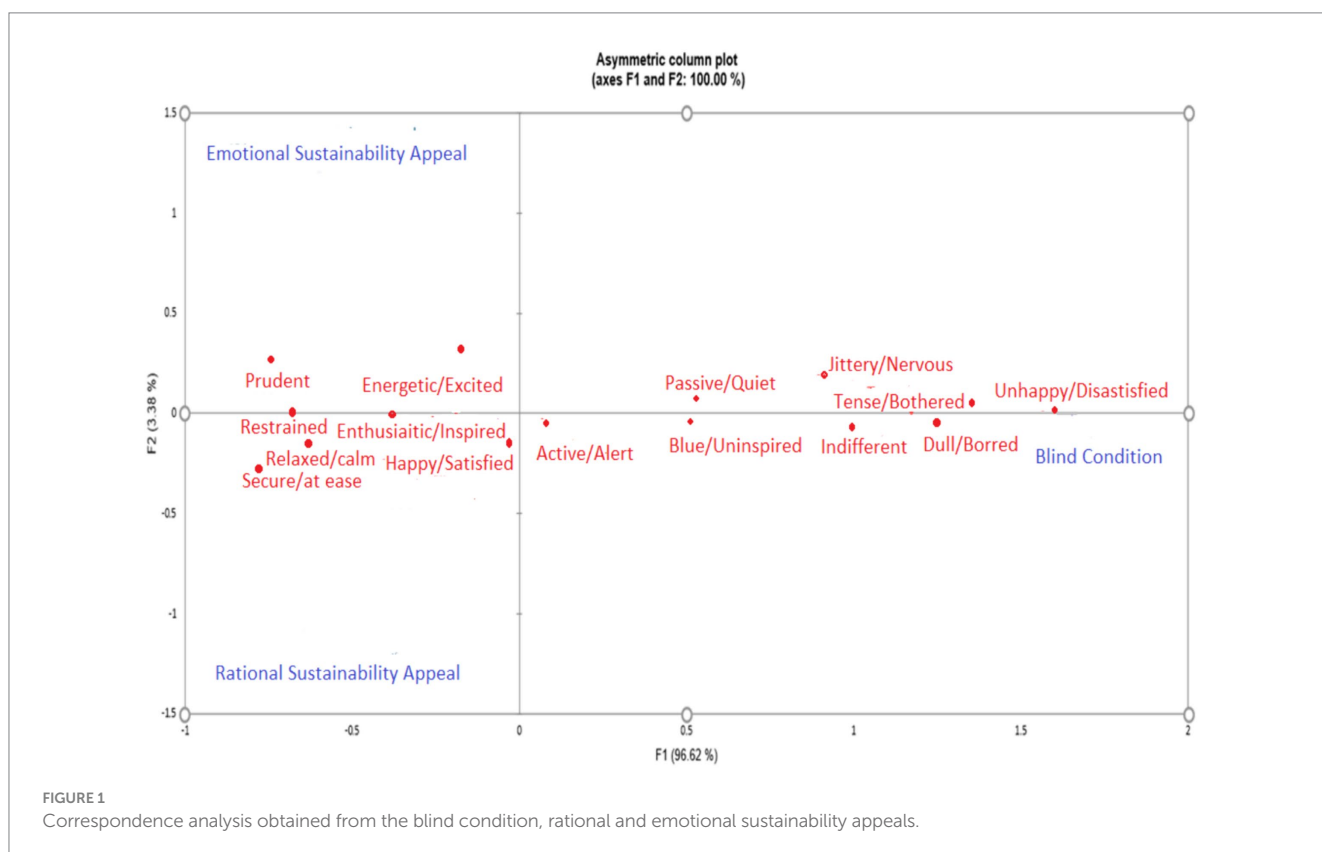
samples evaluated under rational and emotional sustainability appeals scored the highest liking scores than the blind condition. Further, rational sustainability appeal received higher liking scores than emotional sustainability appeal. Hence, the results confirmed that sustainability appeals change the perceptions of respondents toward bran-wheat roti and compel them to start liking it.

2.4.6 Emotional profiles of roti samples under three different evaluation conditions

The results of the analysis of emotional responses for three different roti samples under three different evaluation conditions are given in Table 1. Under the blind condition, the emotion-based terms “Blue/Uninspired” (39.5%), “Indifferent” (35.5%), “Jittery/Nervous” (30.3%), and “Passive/Quiet” (22.4%) were selected with the highest frequency. Under the emotional sustainability appeal, “Energetic/Excited” (69.2%), “Prudent” (59.1%), “Active/Alert” (43.3%) and “Enthusiastic/Inspired” (40.8%) were selected with the highest frequency. Under the rational sustainability appeal, “Enthusiastic/Inspired” (64.1%), “Enthusiastic/Inspired” (64.1%), “Active/Alert” (55.1%), “Prudent” (52.6%), “Secure/At ease” (48.7%), “Happy/Satisfied” (44.9%), and “Energetic/Excited” (37.2%) were selected with the highest frequency.

Results of the study show that under blind condition, respondents expressed negative emotions. While under emotional and rational sustainability appeals, respondents expressed positive emotions. The citation frequency of positive emotions was higher under rational sustainability appeal than under emotional sustainability appeal.

Figure 1 represents correspondence analysis (CA) and the association of the samples and emotions under three different evaluation conditions. The first (F1) and second dimension (F2) account for 100% of the data variability (93.20 and 6.80% respectively).



All three evaluation conditions are grouped separately. Blind condition is associated with negative emotions “Unhappy/Dissatisfied,” “Passive/Quiet,” “Jittery/Nervous,” “Indifferent” and “Blue/Uninspired,” while rational and emotional sustainability appeals are associated with positive emotions. The rational appeal is associated with “Happy/Satisfied,” “Restrained,” “Secure/At ease,” “Enthusiastic/Inspired,” “Restrained,” and “Relaxed/Calm,” and emotional appeal is associated with “Prudent” and “Energetic/Excited.”

The results of the Principal Component Analysis (Figure 2) confirmed that all three evaluation conditions grouped separately. Blind condition is associated with negative emotions, while rational and emotional sustainability appeals are associated with positive emotions

3 Discussion

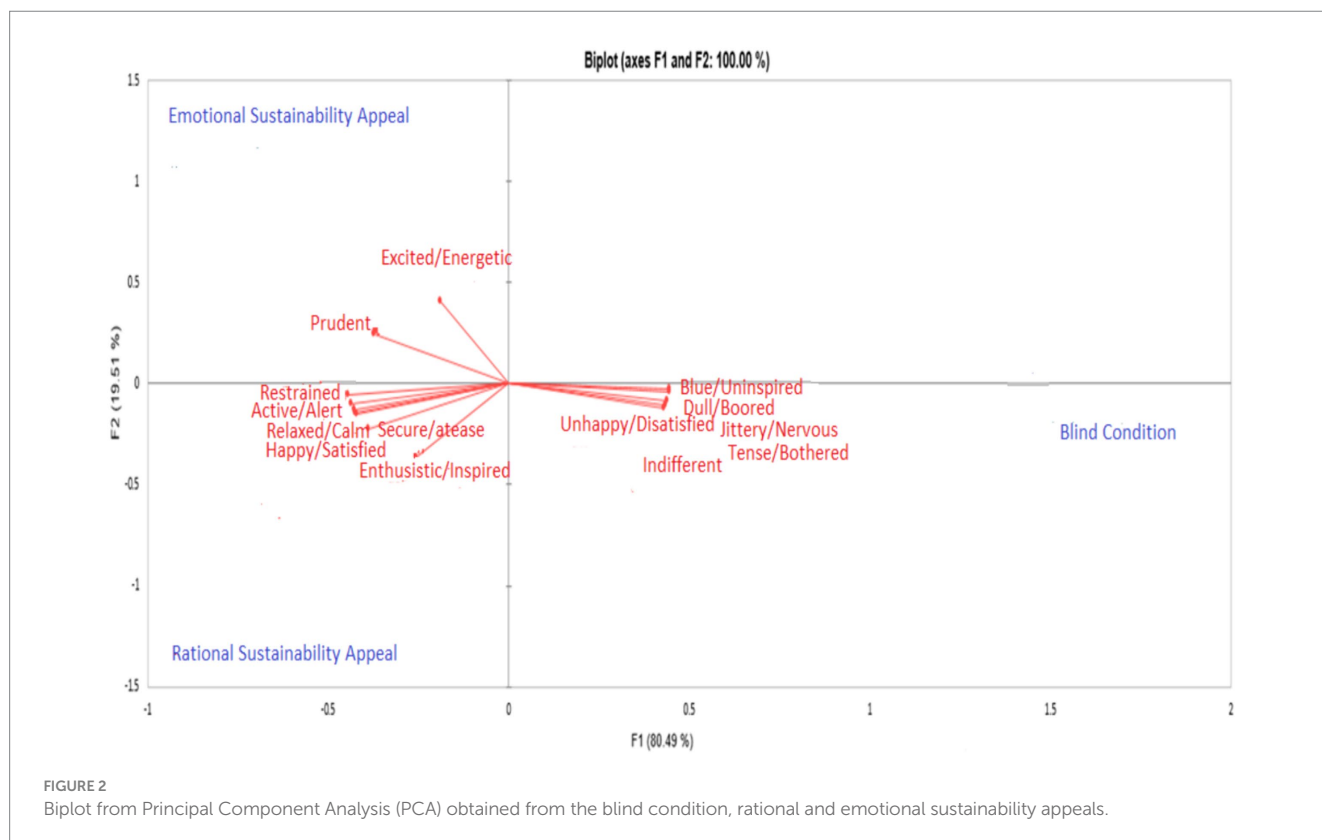
Food wastage and shortage issues are getting worse day by day (Lipinski et al., 2016; Hegnsholt et al., 2018; Gunders, 2012). Agriculture by-products provide a promising solution by handling the issue close to the source of food waste (Bhatt et al., 2018). Despite the benefits, consumer avoids it because of its low sensory properties. Literature supports that sustainability claims could enhance willingness to pay for upcycled food. However, no research has conducted to analyze how sustainability appeals effect sensory perceptions and emotions. So, this research study aimed to fill this gap.

The results of the sensory evaluation revealed that sustainability appeals had positive effects on the sensory perception of 10–90% and 20–80% bran-wheat roti samples. The results confirmed that sustainability appeals played a successful role in improving the sensory perceptions of consumers and triggering their positive emotions toward upcycled food. The results are in line with the results of

Giannoutsos et al. (2023), who found that sustainable packaging information had a positive impact on the sensory profile of the product.

Results further revealed that rational sustainability appeal had higher sensory liking scores than emotional sustainability appeal. The findings are in line with the results of Bhatt et al. (2020), who found rational sustainability appeal more effective in enhancing acceptance of upcycled food than emotional sustainability appeal. Now, consumers have started to focus on the sustainability of the environment and agriculture. Consumers have started developing concerns about food shortages and future needs. Natural disasters, wars, and food processing practices are contributing to food loss and shortage. Our results support that appropriate communication highlighting food loss and its effect on generations could affect acceptance of upcycled food. The results of our study are also supported by the findings of Eagly and Chaiken (1984), who found cognitive appeals more effective for persuasion.

However, for the 30–70% bran-wheat roti sample, results revealed that sustainability appeal had failed to affect the sensory perceptions of consumers; the results are in line with Mora et al. (2020), who found the insignificant effect of sustainability claim on the sensory perceptions of consumers toward dip sauce made vegetables by-product. The differences found in taste and texture; unacceptable (bitter; found during conversation section) taste and granular texture than usual wheat roti made it strange for respondents. Sustainability appeals might fail to have significant effects due to these major differences in sensory attributes. Literature also supports our results by confirming that sensory properties have more influence on developing food liking and choices than extrinsic properties (message) (Mora et al., 2020; Janssen and Hamm, 2012; Vázquez-Araújo et al., 2012). Flour replaced by 20% of bran does not disturb food process ability, quality, and acceptability (Singh et al., 2012). However up to 20% may affect sensory characteristics of food, and any



addition that makes it unpalatable decreases the chances of consumer acceptance (Kühne et al., 2010).

In addition, the results of our study could be associated with the product category: traditional or innovative. Roti is a traditional staple food of Pakistan, eaten three times a day. Being traditional staple food, respondents might have given more importance to hedonic benefits than the extrinsic properties (messages associated with each sample). Wheat flour replaced by 30% bran produced great differences in the sensory quality of roti, which might have made it unacceptable for respondents even after the sustainability appeal. Our findings are in line with the results of Kühne et al. (2010), who suggested preserving the traditional state of the food as prerequisite for innovation in traditional food recipes and products. Similar results were found by Lyly et al. (2007), who found a decline in consumers' willingness to pay for beverages and soups after the addition of β -glucan and even health claims failed to attract consumers.

The research also studies the emotions evoked by two different sustainability appeals. The results show that sustainability appeals evoked positive product emotions; our findings are in line with the results of Giannoutsos et al. (2023). Rational and emotional sustainability appeals evoked positive emotions. However, rational sustainability appeal evoked more positive emotions with greater frequency than emotional sustainability appeal.

4 Conclusion

Food wastage and shortage issues are getting worse day by day (Lipinski et al., 2016; Hegnsholt et al., 2018; Gunders, 2012). Agriculture by-products provide a promising solution by handling the issue close to the source of food waste (Bhatt et al., 2018). Despite the benefits, consumer avoids it because of its low sensory properties. However the results of our study prove that sustainability claims could enhance sensory perceptions and evoke positive emotions toward food prepared from food by-products. The results of this study confirmed that sustainability appeals played a successful role in improving the sensory perceptions of consumers and triggering their positive emotions toward upcycled food.

However, any addition to food that makes it unpalatable decreases the effectiveness of sustainability appeal. Results further show that rational appeal is more effective in promoting sustainability, enhancing sensory perceptions and inciting positive emotions than emotional appeal.

Although upcycling of food is not common in the world, however (developing) countries like Pakistan must promote the upcycling of food. The agriculture system of Pakistan is not enough to support the population of 240 million. Pakistan's agriculture sector is more vulnerable to natural disasters as it lacks basic infrastructure such as dams or canal systems to support agricultural needs. In this scenario, upcycling is the need of the hour. Marketers should use suitable marketing communication tools to highlight the importance of upcycling to feed future generations. For instance, rational sustainability appeals could help to realize the impact of food wastage and food losses on current and future generations. This realization might help in accepting upcycled food.

As we focused on only two message appeals, future studies could test the effectiveness of other message appeals. Similarly, this study experimented on a traditional staple food; future studies could

consider other food categories, novel foods, and unfamiliar tastes to test the effectiveness of different message appeals.

In Experiment 2, the major representatives of the sample were men, so future research studies may focus on females or draw a comparison between genders.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

This study follows all ethical measures of human involvement instructed by the Research Ethics Committee, KFUEIT and the 1964 Helsinki Declaration and ethical standards. Respondents were informed about experimental procedures, and their consent to participate in the experiment was taken in writing before the start of the study. This study follows all ethical measures of human involvement instructed by the institutional research ethics committee of Khawaja Fareed University of Engineering and Information Technology. Approval for experimental procedures was taken in writing from the Research Ethics Committee, KFUEIT; reference number: No. KFUEIT/REC/2023/79. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

MA: Writing – original draft, Writing – review & editing, Conceptualization. SG: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. SM: Investigation, Methodology, Writing – review & editing. MR: Writing – review & editing, Investigation.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

- Abbey, J. D., and Meloy, M. G. (2017). Attention by design: using attention checks to detect inattentive respondents and improve data quality. *J. Oper. Manag.* 53–56, 63–70. doi: 10.1016/j.jom.2017.06.001
- Ammann, J., Mack, G., El Benni, N., Jin, S., Newell-Price, P., Tindale, S., et al. (2024). Consumers across five European countries prioritise animal welfare above environmental sustainability when buying meat and dairy products. *Food Qual. Prefer.* 117:105179. doi: 10.1016/j.foodqual.2024.105179
- Armstrong, G., Adam, S., Denize, S., and Kotler, P. (2014). Principles of marketing. Sydney NSW, Australia Pearson Australia.
- Ayala-Zavala, J. F., Vega-Vega, V., Rosas-Domínguez, C., Palafox-Carlos, H., Villa-Rodríguez, J. A., Siddiqui, M. W., et al. (2011). Agro-industrial potential of exotic fruit byproducts as a source of food additives. *Food Res. Int.* 44, 1866–1874. doi: 10.1016/j.foodres.2011.02.021
- American Association of Cereal Chemists. (2000). Approved Methods Committee. Approved methods of the American association of cereal chemists (Vol. 1). American Association of Cereal Chemists.
- Bhatt, S., Lee, J., Deutsch, J., Ayaz, H., Fulton, B., and Suri, R. (2018). From food waste to value-added surplus products (VASP): consumer acceptance of a novel food product category. *J. Consum. Behav.* 17, 57–63. doi: 10.1002/cb.1689
- Bhatt, S., Ye, H., Deutsch, J., Ayaz, H., and Suri, R. (2020). Consumers' willingness to pay for upcycled foods. *Food Qual. Prefer.* 86:104035. doi: 10.1016/j.foodqual.2020.104035
- Copeland, M. T. (1924). Sacramento Supercenter. Sacramento, CA.
- Das Neves, M. A., Kimura, T., Shimizu, N., and Shiiba, K. (2006). Production of alcohol by simultaneous saccharification and fermentation of low-grade wheat flour. *Braz. Arch. Biol. Technol.* 49, 481–490. doi: 10.1590/s1516-89132006000400017
- Dungani, R., Karina, M., Subyakto Sulaeman, A., Hermawan, D., and Hadiyane, A. (2016). Agricultural waste fibers towards sustainability and advanced utilization: a review. *Asian J. Plant Sci.* 15, 42–55. doi: 10.3923/ajps.2016.42.55
- Eagly, A. H., and Chaiken, S. (1984). Cognitive theories of persuasion. *Adv. Exp. Soc. Psychol.* 17, 267–359. doi: 10.1016/S0065-2601(08)60122-7
- Ekelund, L., Fernqvist, F., and Tjärnemo, H. (2007). Consumer preferences for domestic and organically labelled vegetables in Sweden. *Acta Agric. Scand. C Food Econ.* 4, 229–236. doi: 10.1080/16507540701800665
- Erhard, A., Jahn, S., and Boztug, Y. (2024). Tasty or sustainable? Goal conflict in plant-based food choice. *Food Qual. Prefer.* 120:105237. doi: 10.1016/j.foodqual.2024.105237
- FAO (2019). "The state of food and agriculture—moving forward on food loss and waste reduction" in Routledge Handbook of Religion and Ecology. Available at: <https://www.fao.org/state-of-food-agriculture/2019/en/>
- Fernqvist, F., and Ekelund, L. (2014). Credence and the effect on consumer liking of food - a review. *Food Qual. Prefer.* 32, 340–353. doi: 10.1016/j.foodqual.2013.10.005
- Ford, H., Thibodeau, M., Newton, L., Child, C., and Yang, Q. (2024). Investigating the effect of sharing environmental information on consumer responses to conventional and hypothetical 'precision fermented' yoghurt. *Int. J. Food Sci. Technol.* 59, 8490–8500. doi: 10.1111/ijfs.17228
- García, M. L., Dominguez, R., Galvez, M. D., Casas, C., and Selgas, M. D. (2002). Utilization of cereal and fruit fibres in low fat dry fermented sausages. *Meat Sci.* 60, 227–236. doi: 10.1016/S0309-1740(01)00125-5
- Ghazanfar, S., Abdullah, M., Ummar, R., Shabbir, R., and Saqib, S. (2022). Effect of sustainability claim on willingness to pay for upcycled food in digital era: differential effect of sustainability claim between virtue and vice product category. *Front. Environ. Sci.* 10:870401. doi: 10.3389/fenvs.2022.870401
- Giannoutsos, K., Koukoumaki, D. I., Panagiotou, M., and Gkatzionis, K. (2023). The effect of modern claim related to packaging sustainability on the sensory perception of traditional Greek rusks (paximathi). *Food Qual. Prefer.* 106:104817. doi: 10.1016/j.foodqual.2023.104817
- Giezenaar, C., Jonathan, A., Foster, M., and Hort, J. (2024). Effects of intrinsic and extrinsic product characteristics related to protein source, health and environmental sustainability, on product choice and sensory evaluation of meatballs and plant-based alternatives. *Food Qual. Prefer.* 113:105070. doi: 10.1016/j.foodqual.2023.105070
- Gómez, M., Jiménez, S., Ruiz, E., and Oliete, B. (2011). Effect of extruded wheat bran on dough rheology and bread quality. *Lwt* 44, 2231–2237. doi: 10.1016/j.lwt.2011.06.006
- Guinders, D. (2012). Wasted: How America is losing up to 40 percent of its food from farm to fork to landfill. NRDC Issue Paper, August, 1–26 Available at: http://www.nrdc.org/food/files/wasted-food-IP.pdf?mkt_tok=3RkMMJWf9wsRouujPZKXonjHpfSx56+woXaS11MI/0ER3fOvrPufGjI4ATMphI/qLAzICFpZo2FFUH+GbbIFU8g
- Haridas Rao, P., and Sai Manohar, R. (2003). "Chapatis and related products" in Encyclopedia of Food and Health, 1033–1044.
- Heath, R. G., Nairn, A. C., and Bottomley, P. A. (2009). How emotive is creativity: attention levels and TV advertising. *J. Advert. Res.* 49, 450–463. doi: 10.2501/S0021849909091077
- Hegnsholt, E., Unnikrishnan, S., Pollmann-Larsen, M., Askelsdottir, B., and Gerard, M. (2018). Tackling the 1.6-billion-ton food loss and waste crisis: The Boston Consulting Group, 1–10 Available at: <https://www.bcg.com/publications/2018/tackling-1.6-billion-ton-food-loss-and-waste-crisis.aspx%0Ahttp://www.dandc.eu/en/article/lots-food-wasted-worldwide-aid-agency-efforts-improve-matters-hardly-help-poor>
- Heiniö, R. L., Noort, M. W. J., Katina, K., Alam, S. A., Sozer, N., de Kock, H. L., et al. (2016). Sensory characteristics of wholegrain and bran-rich cereal foods - a review. *Trends Food Sci. Technol.* 47, 25–38. doi: 10.1016/j.tifs.2015.11.002
- Hemery, Y., Chaurand, M., Holopainen, U., Lampi, A. M., Lehtinen, P., Piironen, V., et al. (2011). Potential of dry fractionation of wheat bran for the development of food ingredients, part I: influence of ultra-fine grinding. *J. Cereal Sci.* 53, 1–8. doi: 10.1016/j.jcs.2010.09.005
- Henchion, M., McCarthy, M., and O'Callaghan, J. (2016). Transforming beef by-products into valuable ingredients: which spell/recipe to use? *Front. Nutr.* 3:53. doi: 10.3389/fnut.2016.00053
- Jaeger, S. R., Roigard, C. M., and Chheang, S. L. (2021). The valence × arousal circumplex-inspired emotion questionnaire (CEQ): effect of response format and question layout. *Food Qual. Prefer.* 90:104172. doi: 10.1016/j.foodqual.2020.104172
- Jaeger, S. R., Roigard, C. M., Jin, D., Xia, Y. X., Zhong, F., and Hedderley, D. I. (2020). A single-response emotion word questionnaire for measuring product-related emotional associations inspired by a circumplex model of core affect: method characterisation with an applied focus. *Food Qual. Prefer.* 83:103805. doi: 10.1016/j.foodqual.2019.103805
- Janssen, M., and Hamm, U. (2012). Product labelling in the market for organic food: consumer preferences and willingness-to-pay for different organic certification logos. *Food Qual. Prefer.* 25, 9–22. doi: 10.1016/j.foodqual.2011.12.004
- Januszewska, R., Mettepenningen, E., Majchrzak, D., Williams, H. G., Mazur, J., Reichl, P., et al. (2013). Regional embeddedness segments across fifteen countries. *J. Culinary Sci. Technol.* 11, 322–335. doi: 10.1080/15428052.2013.798603
- Junejo, S. A., Zhang, L., Yang, L., Wang, N., Zhou, Y., Xia, Y., et al. (2019). Anti-hyperlipidemic and hepatoprotective properties of wheat bran with different particle sizes. *Journal of the Science of Food and Agriculture*, 99, 1990–1996.
- Krishnan, T. V., and Jain, D. C. (2006). Optimal dynamic advertising policy for new products. *Manag. Sci.* 52, 1957–1969. doi: 10.1287/mnsc.1060.0585
- Kühne, B., Gellynck, X., and Weaver, R. D. (2010). "Network connections and innovation capacity in traditional agrifood chains. 116 TH EAAE SEMINAR" in Spatial dynamics in Agri-food systems: implications for sustainability and consumer welfare, March 2014, 1–18.
- Lee, E. H., Yeom, H. J., Ha, M. S., and Bae, D. H. (2010). Development of banana peel jelly and its antioxidant and textural properties. *Food Sci. Biotechnol.* 19, 449–455. doi: 10.1007/s10068-010-0063-5
- Lipinski, B., Hanson, C., Lomax, J., Kitinoja, L., Waite, R., and Searchinger, T. (2016). Toward a sustainable food system reducing food loss and waste: World Resource Institute, June, 1–40 Available at: <http://unep.org/wed/docs/WRI-UNEP-Reducing-Food-Loss-and-Waste.pdf%5Cnhttp://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/130211>
- Lyly, M., Roininen, K., Honkapää, K., Poutanen, K., and Lähteenmäki, L. (2007). Factors influencing consumers' willingness to use beverages and ready-to-eat frozen soups containing oat β -glucan in Finland, France and Sweden. *Food Qual. Prefer.* 18, 51–53. doi: 10.1016/j.foodqual.2005.12.001
- Metha, A., and Purvis, S. C. (2006). Reconsidering recall and emotion in advertising. *J. Advert. Res.* 46, 51–53. doi: 10.2501/S0021849906060065
- Mora, M., Romeo-Arroyo, E., Torán-Perep, P., Chaya, C., and Vázquez-Araújo, L. (2020). Sustainable and health claims vs sensory properties: consumers' opinions and

- choices using a vegetable dip as example product. *Food Res. Int.* 137:109521. doi: 10.1016/j.foodres.2020.109521
- Rahman, A., Ulven, C., Durant, C., Johnson, M., Fehrenbach, J., and Hossain, K. G. (2017). Selection, pretreatment, and use of wheat bran for making thermoplastic composite. In American Society of Agricultural and Biological Engineers (Eds.), 2017 ASABE annual international meeting.
- Rizwan, M., Pirzada, S., Sohail, A., Nadeem, M., and Murid, W. (2013). The role of advertising appeals, role of Celebrity & Expert in TV advertising attitude. *IOSR. J. Bus. Manag.* 52:57. Available at: https://www.researchgate.net/publication/345983576_The_Role_of_Advertising_Appeals_Role_of_Celebrity_Expert_in_TV_Advertising_Attitude%0Awww.iosrjournals.org
- Singh, M., Liu, S. X., and Vaughn, S. F. (2012). Effect of corn bran as dietary fiber addition on baking and sensory quality. *Biocatal. Agric. Biotechnol.* 1, 348–352. doi: 10.1016/j.bcab.2012.02.005
- Sozer, N., Cicerelli, L., Heiniö, R. L., and Poutanen, K. (2014). Effect of wheat bran addition on invitro starch digestibility, physico-mechanical and sensory properties of biscuits. *J. Cereal Sci.* 60, 105–113. doi: 10.1016/j.jcs.2014.01.022
- Stanyon, P., and Costello, C. (1990). Effects of wheat bran and Polydextrose on the sensory characteristics of biscuits. *Cereal Chem.* 67, 545–547. Available at: http://online.cerealsgrains.org/publications/cc/backissues/1990/documents/67_545.pdf
- UNEP. (2021). Food waste index report 2021. In Unep Food Waste Index Report 2021. Available at: <https://www.unep.org/resources/report/unep-food-waste-index-report-2021>.
- Vázquez-Araújo, L., Chambers Iv, E., and Cherdchu, P. (2012). Consumer input for developing human food products made with Sorghum grain. *J. Food Sci.* 77, S384–S389. doi: 10.1111/j.1750-3841.2012.02917.x
- Wang, Z., Wang, W., Xu, S., Ding, J., Zeng, X., Liu, H., et al. (2023). Diets enriched with finely ground wheat bran alter digesta passage rate and composition of the gut microbiome in sows. *Anim. Nutr.* 12, 32–41. doi: 10.1016/j.aninu.2022.08.012
- Xie, X., Cui, S. W., Li, W., and Tsao, R. (2008). Isolation and characterization of wheat bran starch. *Food Res. Int.* 41, 882–887. doi: 10.1016/j.foodres.2008.07.016
- Yoo, C., and Deborah, M. (2005). The brand attitude formation process of emotional and informational ads. *J. Bus. Res.* 58, 1397–1406. doi: 10.1016/j.jbusres.2005.03.011
- Zhang, D., and Moore, W. R. (1997). Effect of wheat bran particle size on dough rheological properties. *J. Sci. Food Agric.* 74, 490–496.
- Zhang, D., and Moore, W. R. (1999). Wheat bran particle size effects on bread baking performance and quality. *J. Sci. Food Agric.* 79, 805–809.
- Zhang, J., Ye, H., Bhatt, S., Jeong, H., Deutsch, J., Ayaz, H., et al. (2021). Addressing food waste: how to position upcycled foods to different generations. *J. Consum. Behav.* 20, 242–250. doi: 10.1002/cb.1844