Modifying the Visual-Texture Complexity of Foods to Direct Consumers' Attention Toward More Sustainable Options: Turkish Rice Pudding 'Sütlaç' as a Case

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Abstract

The importance of visual elements and textures has been emphasized in sensory analysis studies examining consumer preferences, and these data have been used in the field of neomarketing to examine consumers' conscious or unconscious choices. This study focused on the possibility of directing consumers' attention to sustainable options by using the visual textural properties of products. This approach aimed to find solutions to problems such as carbon emissions and water pollution resulting from food production. Rice pudding, a traditional dessert, was chosen as the reference sample in this research. To create the study samples, the amount of rice pudding was halved and gradually added more sustainable plant-based products with four different textural characteristics. For visual sensory analysis, visual stimuli were prepared and loaded into the computer for two comparisons. The study was conducted in an isolated environment with one hundred randomly selected participants among university students. Descriptive analyzes and t-test were preferred to analyze the results. Participants' product preference increased from textural complexity to specific complexity. Instead of the original recipe, participants preferred a milk dessert with reduced milk and rice content, which was modified to reduce carbon emissions. In addition, with the tissue complexity, the energy value of the products decreased to a certain point. The impact of product description in menu format on consumers' preferences was also examined and observed to have an impact. With this study, the industry can direct consumers to more sustainable options for a more sustainable future.

Keywords: Food Sensory; sustainability; textural complexity; visual texture

1. INTRODUCTION

Food, which has emotional and cultural dimensions, is an important part of human sensory. When products are seen by the consumer, their perception and preferences may be unconscious. Neurogastronomy approaches our perceptions of food in a multidisciplinary way (Kivela & Crotts, 2006). Neurogastronomy is a branch of science that studies the role of the brain during the consumption of food. Neurogastronomy may help us understand food sensory and taste preferences (Kanwal, 2016). With studies such as neurogastronomy, ways can be found to direct people to foods that are more beneficial to themselves and their environment (WCED, 1987). Food innovation can improve the quality, safety, sustainability, and accessibility of food (Hu, 2010).

Food sensory, innovation, neurogastronomy and sustainability are important concepts in the food industry and are intertwined.

In this study, all these concepts are combined. The hypotheses in this study were determined as follows:

H_0; There will be no significant difference in consumer preference between the modified dairy dessert and the original recipe across various levels of textural complexity, thus not affecting carbon emissions from the food choice.

H_1; Consumers will exhibit a preference for the modified dairy dessert with reduced milk content over the original recipe, leading to decrease in carbon emissions associated with beef-derived milk, as the textural complexity of the product varies.

Based on these hypotheses, food innovation was carried out together with neuromarketing and perception studies and sustainable options were obtained. Participants' preferences were examined.

1.1. Consumer Food Preference: Sensory Science to Cultural Perceptions

Sensory analysis, as studied by Drake (2007), is a powerful and sensitive tool to measure both qualitative and quantitative sensory attributes of food products including aroma, appearance, flavor, texture, aftertaste and sound, and consumer reactions to foods and other product (Drake, 2007: Murray, Delahunty, & Baxter, 2001).

From a historical perspective, interest in sensory analysis emerged in the 1940s and developed in the 1960s and 1970s as it is a valuable tool that is frequently used in the determination of the quality of existing foods, and the development of new food products (Chollet & Valentin, 2001).

Sensory analyzes are basically divided into three. Discriminative sensory analysis identifies differences between two or more products (Murray, Delahunty, & Baxter, 2001). Descriptive sensory analysis is widely used to characterize the aroma, mouth texture and flavor of food products (Meilgaard, Carr, & Civille, 1999). Consumer acceptance tests measure the degree of liking or disliking of a food product, influencing conscious responses during sensory evaluation (Torrico, at al., 2018).

Transitioning from sensory analysis to consumer preferences, the profound impact of internal and external sensory cues on consumers` food preferences is encountered (Richardson, Dick, & Jain, 1994).

Consumers sensory evaluation of a product starts with visual stimulation. Unraveling the complexities of visual stimulation, it has been discovered that visual processing involves perceiving factors like shape, color, light, and motion, followed by the evaluation of the product's visual appeal (Bakalar, 2012). For example, the shape of the product is an important criterion for consumers, with typical shapes perceived as having better quality. When faced with an unconventional shaped product, consumers tend to use typical shapes as a cognitive reference for evaluation (Loebnitz, Schuitema, & Grunert, 2015). However, when consumers are motivated to address the incongruity, they tend to prefer products that can be considered moderately normal rather than entirely normal or abnormal (Peracchio & Tybout, 1996). This suggests that consumers have higher purchase intentions for foods with typical shapes than those with moderately or extremely abnormally shapes. The colors of the product are also important in sensory perception, impacting taste and quality perceptions (İmram, 1999).

Simultaneously, visual content, besides product cues, including pictures, videos, and advertisements, is also important to attract the attention of consumers as human brain processing visual information 60,000 times faster than text. It influences consumer preferences, and affect their choices (Raghubir, 2011, Diamond, 2013). For example, delicious food photos grasp the consumers' attention, influence them, and impact their purchasing decisions. These data highlight the importance of visual content in modern marketing, as it significantly affects our choices (Diamond, 2013).

Shifting the attention to external cues, elements such as label and price, which are external clues of the product, play a significant role in consumers' choices. For example, information regarding organic food production, which consumers cannot judge independently, can influence their purchasing behavior when specified on labels (Loebnitz, Schuitema, & Grunert, 2015).

Combining external cues such as perceived availability or high prices, may decrease purchasing intention (Griskevicius, Tybur, & Van den Bersh, 2010). In line with this understanding, presentation of information about the product on labels can affect both visual attention and consumer behavior (Koenigstorfer, Wasowicz-Kirylo, Stysko-Kunkowska, & Groeppel-Klein, 2013). Consumers frequently express that their food choices are motivated, at least in part, by health concerns. Health-conscious consumers seek for information to access the healthiness of the food options, that influence their choices (Graham, Orquin, & Visschers, 2012).

1.2. Food Texture and Consumer Food Perceptions

Texture can be defined as the combination of the rheological and structural properties of the product that can be perceived through mechanical, tactile, visual, and auditory receptors (Lawless & Heymann, 2010). Comprehensive studies on consumers` attitudes towards food texture were conducted by the General Foods Group and published in the 1960s and 1970s (Szczesniak, 2002).

Food texture provides sensory signals to consumers, and attracts their attention and contributes to the overall sensory experience (Civille, 2011). A study conducted by ten chefs, working in Michelin-starred restaurants in France, revealed that chefs strategically use various textures, tastes, aromas, and appearances to create sensory complexity, enhancing the flavor, interest, satisfaction of meals, and to market their products (Palczak, Giboreau, Rogeaux, & Delarue, 2020).

Additionally, foods with more complex textures require longer chewing and digestion time, helping consumers stay full for longer (Szczesniak, 2002). However, an excessive increase in texture complexity may hinder chewing and digesting foods, making food less palatable (Kim, 2016).

Soft textured foods are attractive to individuals of all age groups and can be used to create a variety of delicious and satisfying dishes (Mouritsen & Styrbaek, 2017). Crispy and crunchy textures have been described as complementary to flavor and indicative of freshness (Kilcast & Fillon, 2001). A cross cultural study conducted with Chinese, Korean and American participants showed that consumers preferred crispy texture in dried fruits and vegetables (Wong, Kim, Chung, & Cho, 2020). In another study, consumers preferred crispy, crunchy and crisp-tender textures than other textures in fruits and vegetables (Kilcast & Fillon, 2001). Airy (foamy) texture involves air bubbles in the food structure, and they contribute to a food's overall texture. Foods with high air content typically have a light and fluffy texture, which can make foods more appealing, and contribute to flavor, as seen in whipped cream (Mouritsen & Styrbaek, 2017).

1.3. Neuromarketing in Food Science

The concept of neuromarketing, first defined by Ale Smidts in 2002, investigates the complex cognitive mechanism that shape consumer behavior and improve marketing strategies (Boricean, 2009). In food decision-making, the unconscious mind plays a crucial role, which is influenced by complex emotions, feelings, attitudes and values (Stasi, et al.,2018) Using these developments, researchers evaluate the factors that affect the consumer behaviors by applying techniques from psychology and neuroscience. Consumer neuroscience research employs neuroscience tools and methods to develop a better understanding of consumer behavior, decision-making, and related processes (Kenning & Plassmann, 2008). For example, various elements ranging from visual components of advertisement to the color of the package, or features of a food product can be a motivator in consumer`s decision-making process (Schiffman & Wisenblit, 2019).

In neuromarketing studies, the aim is to evaluate customer behavior using innovative approaches rather than solely using traditional method, which directly questions the customer. Various factors influence the consumer's decision-making process and choice, including their mood or emotional mindset (Schiffman & Wisenblit, 2019). Implicit techniques, commonly known as non-cognitive or non-conscious evaluations, are often marketed as more in-depth analyzes of consumer psychology (Niedziela & Ambroze, 2021). Consumer neuroscience researches employ neuroscience tools and methods to better understand consumer behavior, decision-making, and related processes (Kenning & Plassmann, 2008).

The application of neuroscience tools in consumer and sensory researches, particularly in food product development, may help to better understand consumers' subconscious motivations in purchasing decisions. Studies on how the brain interprets these signals has led to the formation of a new scientific field known as neurogastronomy (Kanwal, 2016).

Neurogastronomy examines the complex relationship between the brain and the perception of flavor, expanding beyond the traditional understanding that flavor is explained solely by the combination of taste and smell (Stasi, et al., 2018).

1.4. Sustainable Food Production and Carbon Emissions in Food Production

One of the main causes of the world`s environmental problems is greenhouse gas emissions from industrial activities, which has a detrimental impact on land system changes, biodiversity loss, freshwater consumption, climate change, and global nitrogen and phosphorus cycles. Furthermore, climate change due to continued increase in greenhouse gas emissions has a direct negative effect on global food security (Cui, et al.,2023) Climate change, biodiversity loss, land degradation, water scarcity and water pollution are factors that threaten long-term food security, partly due to current diets and partly due to agricultural practices (Rose, Heller, & Roberto, 2019).

According to the United Nations report, greenhouse gas emissions have accelerated in the last decade. Food systems have been found to account for 19-29% of greenhouse gas emissions (Camilleri, Larrick, Hossain, & Patio-Echeverri, 2019). Therefore, there is a need to reduce greenhouse gas emissions including carbon dioxide, methane, nitrous oxide, dichlorodifluromethane, and hydrochlorofluorocarbon from the food production chain (Jin & Kim, 2018).

According to the food life cycle studies, the environmental impact of animal husbandry and meat products are generally more detrimental compared to other food products in the chain. Particularly, the production of meat, fish and dairy commonly has a greater environmental impact than the production of fruits and vegetables (Xu, et al.,2021). Another important point in terms of food sustainability is depletion of fresh water resources. Within the food production chain, significant amount of (98%) the total water usage is associated with the water footprint of feed produced for animal husbandry (Mekonnen & Hoekstra, 2010). Globally, animal husbandry requires approximately 2422 Gm3 of water per year. These figures highlight the role of animal husbandry in food production chain, and the importance of addressing water sustainability in the food production chain (Willet, et al., 2019). Therefore, changing consumption habits is an important behavioral strategy to reduce environmental impacts of food production (Camilleri, Larrick, Hossain, & Patio-Echeverri, 2019).

However, when we consider products of non-animal origin, we can see that some products are not suitable for sustainability. For example, rice is the third most produced agricultural product globally, following wheat and corn. In rice cultivation, paddy is produced entirely on irrigated ground. As a result of the decomposition of organic substances in this water in an oxygen-free environment, methane gas is produced. This highlights the environmental effects of rice farming practices, emphasizing the need for sustainable approaches in certain plant-based produces as well (Kayıkçıoğlu & Okur, 2012).

Food sustainability strategies, characterized by low carbon emissions from production to consumption, can make a significant contribution to address this problem (Banerjee, Galizzi, John, & Mourato, 2023). An important component of this strategy is balancing the use of resources, including water, land, and energy. Focusing on food sustainability and resource balance makes the effort to protect the environment more logical and effective (Rose, Heller, & Roberto, 2019).

1.5. Sustainability in Food Choice: Recipe and Menu Modifications and Food Product Development

Increasing the consumption of these food products contributes to a decrease in greenhouse gas emissions from food production. Cattles raised for beef and dairy products are major sources of methane gas emissions. A significant reduction in overall greenhouse gas emissions can be achieved by reducing the consumption of animal-derived foods and shifting to a vegetarian/vegan diet. In a 2016 study, Springman found that a global shift to diets with reduced meat and increased fruits and vegetables could save almost 8 million lives by 2050 by reducing greenhouse gas emissions by two-thirds (Springmann, Charles, Godfray, Rayner, & Scarborough, 2016).

Innovations and sustainable productions in the food sector have become more important with environmental problems and the increase in the world population. However, although they are aware of the importance of food and environmental sustainability, consumers currently have a limited knowledge on sustainable food production and its components (Macdiarmid, Douglas, & Campbell, 2016).

To bridge the gap between consumer knowledge and sustainable consumption behavior, besides governmental actions, professional chefs play a pivotal role by innovating culinary approaches that embrace local sourcing, low and creative integrating new recipes, dishes, and serving with low carbon emission (Global Alliance For The Future Of Food, 2023).

According to the Oslo Manual, innovation is defined as ‘‘the implementation of a new or significantly improved product (good or service) or process, a new marketing method or a new organizational method in internal business practices, workplace organization or external relations (OECD, 2006). In the context of culinary innovation there are seven most common criteria (Hu, 2010) that can be outlined as culture, visual attributes, technology, skills, service, management, creativity.

In the process of developing new product certain stages are followed. Initially, an idea needs be developed based on goals and missions. Following this, a gap in the market is identified and addressed. Subsequent stage is the development of the product itself. In this stage, the product is formulated and the production steps are determined. Then, a prototype is prepared in accordance with the specified production conditions. The prototype undergoes through sensory evaluation tests involving a group of individuals from the target group. Consumers' reactions and preferences towards the prototype are carefully examined. In cases where the product is not preferred or issues arise, necessary improvements are implemented and the iterative process continues until the product gains acceptance within the consumer group. On the other hand, when the product is well accepted, subsequent step is commercialization process. Product formulation involves either developing a fully new product or product modification. (Özilgen, 2019).

2. RESULTS

2.1. Analysis of Carbon Emission and Energy Changes with Textural Complexity

Changes in carbon emissions and the energy values of the sample products with textural complexity are given in Table 1.

From table 1, carbon emission for the pear study samples were less compared to the carbon emissions of the control sample. The most noticeable reduction was observed in SC1 and SC2 complexities, with decreases of 47.39% and 42.62%, respectively. Energy values were also decreased with increased textural complexity. The caramel samples also revealed decrease in carbon emissions. Again, the most noticeable decrease was observed with SC1 (48.17%), followed by SC2 (46.36%). Energy values showed varying trends across different complexities, with SC3 and SC4 showing an increase compared to the control group. Overall, the findings suggest that texture changes significantly influence carbon emission and energy values, with certain complexities leading to more substantial reductions.

2.2. Consumer Preference

For both the pear and the caramel samples, results from paired sample comparisons for both non-Informative and informative groups were analyzed within groups, for the preferences of consumers regarding the various complexities of the texture. Descriptive statistics results and percentages are given in Table 2 and Table 3. Mean, standard deviation and mode values are taken into consideration in descriptive statistics.

As seen from the tables, among the paired samples, consumers in both informative and non-informative pear group showed a preference for samples that had visual textural complexity. They preferred the samples that had higher textural complexity, with the exception of SC3-SC4 samples.

Furthermore, among the paired samples, consumers in non-informative caramel group showed a preference for control samples when C-SC1 and C-SC2 samples were compared. They preferred the samples that had higher textural complexity, for the rest of the samples. On the other hand, among the paired samples, consumers in informative group showed a preference for samples that had visual textural complexity.

2.3. Comparisons of Informative and Non-Informative Study Samples

The research also analyzed the impact of non-informative and informative designs on preferences. Between group analysis were carried out between non-informative and Informative pear groups, and non-informative and informative caramel groups (Table 4). Independent t-test was carried out to examine the p values and identify any significant differences between them.

The results revealed significant differences between C-SC1, C-SC2, C-SC3, C-SC4, CH-SC1, CH-SC2, CH-SC3, CH-SC4, SC3-SC4 for the pear groups and between

between C-SC1, C-SC2, C-SC4, CH-SC1, CH-SC2, CH-SC3, SC2 SC3 for the caramel groups.

2.4. Comparisons of Pear and Caramel Study Samples

Differences between Pear and Caramel samples on preference was also examined. Between group analysis were carried out using the results from Non-Informative and Informative pear and caramel samples, separately (Table 5). Independent Samples t-test was applied, and p value was used to decide significance of the results.

Between the informative group, significant differences were observed between the pear and caramel samples in C-SC2, SC1-SC2, and SC2-SC4 pairings.

3. DISCUSSION

In this study, Sütlaç was chosen as the control group as it is a traditional dessert in Türkiye; and also because its commercial value is high (Şavkay, 2000). Sütlaç contains both beef-derived milk and rice, which, as shown in previous research, have a negative impact on food and environmental sustainability (Xu et al., 2021). Given the attention given to addressing rising greenhouse gas emissions and freshwater pollution (Willet et al., 2019), this research aimed to divert consumers' preferences for more sustainable alternatives to this traditional dessert. To achieve this, the study halved the amount of sütlaç, modified the visual textural complexity, and then evaluated consumers' preferences. This approach allowed for a clearer understanding of how consumers respond to alterations in the traditional recipe, with a focus on sustainability considerations.

3.1. Relationship between Visual Textual Complexity and Consumer Preference

Visual texture was used in the research to direct consumers to more sustainable options, as texture is the major sensory attribute that affects consumer preferences (Stubbs, Johnstone, Mazlan, Mbaiwa, & Ferris, 2001).

Therefore, the study modified the textural properties of the foods to analyze their impact on participants' preferences and divert consumers towards more sustainable options while potentially reducing carbon emissions.

Textural complexity was the study's independent variable.

The smooth texture (SC1) was added first to both pear and caramel samples. Previous studies show that smooth texture is perceived as high quality and preferred by consumers (Daget, Joerg, & Bourne, 1987). Similarly, in this study, SC1 complexity was generally preferred compared to the control group.

The second added texture was the crispy texture (SC2). Pear was chosen as the crispy texture for the pear sample, and caramel pieces were chosen as the crispy texture for the caramel sample. The texture varies with whole or chopped fruit (Kilcast & Fillon, 2001). Therefore, the pears were cut to suit the crispy texture, and the caramel pieces were prepared accordingly. Appropriately adding a visual layout is important (Manic, 2015). Thus, the added products were placed in an orderly manner to increase preference. Upon examination of the results, SC2 complexity is predominantly chosen when compared with C, CH, and SC1.

The crunchy texture (SC3) was the third texture added. Previous research shows that crunchy texture is among the most preferred textures by consumers (Kilcast & Fillon, 2001). Similarly, in this study, consumers preferred SC3 complexity over other texture complexities.

Participants mostly gravitate toward texture-complex products when examining the results up to SC3 complexity in terms of texture differences. This result also supports previous research. Previous studies also show that consumers think products with more complex textures are more delicious, satisfying, and interesting (Szczesniak, 2002).

The fourth texture added was an air texture (SC4). Air texture is perceived as attractive by consumers (Mouritsen & Styrbaek, 2017). However, some previous studies have found that when the texture complexity of foods increases too much, it can become difficult to chew and digest, causing foods to appear less palatable and less nutritious. Therefore, when complexity is increased too much, consumers may turn away from the product (Kim, 2016). Participants in this study generally chose SC3 complexity when presented with SC3-SC4 options. That is, even though the participants preferred products with a complex texture, they did not prefer the fourth level of complexity.

In summary, participants preferred products that were complex in texture, as in previous studies (Palczak, Giboreau, Rogeaux, & Delarue, 2020). However, participants generally preferred SC3 textural complexity over SC4 textural complexity.

3.2. Relationship between Visual Textural Complexity and Consumer Preference and Sample Choice

Visual stimulation is known to influence preferences. Factors such as shape, color, or light in the image affect preferences (Bakalar, 2012). Another study found that using participants' favorite color in desserts did not affect food intake when examining the effect of changing food color on preference. Another study examined the effect of changes in pastry shape on purchasing. Research conducted by Sorensen, Moller, Flint, Martens, & Raben (2003) highlights the significance of shape in determining preferences. At the same time, it is known that the product's position in the image and eye perspective are also important in preferences (Madipakkam, Bellucci, Rothkirch, & Park, 2019). To ensure consistency, we maintained constant eye perspective and the area where preferences were to be made in this sensory study. Participants made their choices alone in a dark and isolated area, away from moving elements.

Criteria in this research did not include color and shape. For this reason, similar colors were used in the pear and caramel samples, even though there are studies showing that this factor does not affect them. The researchers used the same presentation style and the same glass goblet for the shape. Additionally, the effect of the products used was also examined. To eliminate the effect of non-informative and informative groups in this analysis, we examined the informative group and the non-informative group separately. Upon examination of the results (Table 4), it was evident that the caramel and pear samples did not influence the overall preference.

With this result, it would not be right to generalize that the product change indicates a visual preference. Because similar color, light, and presentation are used. Additionally, as stated by Durukan and Türker (2021), there are no increases in motivational preferences in factors such as religion, social events, and food memory. Such factors may affect the products to be preferred. However, this allows selection times to be proven without observing the texture, with no significant differences between the two samples. As stated before, it shows visual textural complexity preferences, as mentioned in the previous studies. It is possible for this product to achieve similar performance. In this way, the forces that diversify the visual texture can create an appeal in the restaurant industry, relatively independent of the product.

3.3. Relationship between Visual Textural Complexity and Consumer Preference and Informative vs. Non-Informative

Informative and non-informative groups were examined. The goal here was to investigate the effect of informing the consumer about the product's content in menu format on their preferences. Therefore, the samples were examined on their own to exclude the influence of pear and caramel products. Preferences made for informative and non-informative caramel samples were compared with each other, and preferences made for informative and non-informative pear samples were compared with each other.

In previous studies, the presence or absence of information in menus was examined, and it was observed that this made a difference (Filimonau & Krivcova, 2017). This research also achieved a similar result. In general, there were significant differences between providing and not providing information about the content in menu format (Table 5). This shows that the function of menu-formatted content information is meaningful. Additionally, he emphasizes that restaurants and other food establishments should give ingredient knowledge a prominent place when designing their menus.

3.4. Evaluation of Preferred Samples in Terms of Carbon Emissions and Energy Values

The study by Bakalar (2012) found that viewing images of high- and low-calorie foods causes different responses in various parts of the brain, with subjects reporting feeling more pleasant when exposed to high-calorie foods.

Participants in another study received a new alternative to their regularly consumed food. There were differences in taste, texture, and appearance in this new food offering. New foods resulted in participants consuming higher calories (Sorensen, Moller, Flint, Martens, & Raben, 2003).

Additionally, some research shows that whether or not information about the content of the product is given affects preferences, especially in terms of healthy choices (Yoon & George, 2012). When we evaluate the energy values, in the pear sample, the energy value decreased compared to the control group in all complexities, while in the caramel sample, the energy value decreased in SC1 and SC2 complexity and increased in SC3 and SC4 complexity.

The increase in energy value in the caramel sample is attributed to SC3 complexity. For the caramel and pear samples, the air texture in SC4 is the same. Participants in both the informative caramel group and the non-informative caramel group preferred this complexity over others, despite the increase in energy value in SC3 complexity. When it came to SC3-SC4, the participants preferred SC4 complexity. However, the energy value in SC4 complexity decreased in percentage compared to SC3. Based on this, it is possible to say that the participants made their choice for the caramel sample regardless of the increase or decrease in the energy value.

When the pear sample was examined, energy values decreased at all complexity levels. Participants preferred increased complexity. Participants' preferences increase as their energy value decreases. However, since there is a factor such as texture, a definitive judgment cannot be made.

When comparing the caramel and pear samples, consumers' preferences in the caramel sample were similar to those in the pear sample, despite the energy increase in the SC3 complex. Participants did not receive any information about energy values. Caloric value alone does not make a difference in visual selection.

In addition, the long-term effects of changing food variety and palatability on energy balance have not yet been determined. Long-term studies conducted in daily natural environments are needed to determine this (Sorensen, Moller, Flint, Martens, & Raben, 2003).

There is widespread scientific consensus on the urgency of reducing greenhouse gas emissions and the need to investigate alternative interventions to do so. Recently, dietary change has also been recognized as a potential solution worth exploring. Behavior change studies often assume that consumers know the connection between their actions and greenhouse gas emissions. However, many studies show that consumers are unaware of or have misinformation on this issue (Camilleri, Larrick, Hossain, & Patio-Echeverri, 2019). On the other hand, depending on the information content on the menus, it has been observed that consumers turn to more sustainable options in addition to healthy foods. Consumers choose products with lower carbon emission values when provided with carbon emission values (Filimonau & Krivcova, 2017). In this research, we directed consumers towards more sustainable options with texture differences. As textures increased, participants generally preferred both the caramel and pear samples in both the informative and non-informative groups. Therefore, as the texture increases, the preference for the decreasing carbon emission value also increases. However, it cannot be claimed that they selected it for its sustainability. Because carbon emission values were reduced in both caramel and pear samples. Participants did not receive any information on this subject. In addition, there was such a decisive parameter as texture.

In general, it cannot be said that consumers choose them because they are more sustainable. The texture factor can guide consumers towards more sustainable products. Restaurant-style businesses can take the initiative for sustainability with this result.

4. CONCLUSION

Consumers have become aware of labels showing carbon emissions. However, people have difficulty understanding these labels. It is also necessary to take into account that consumers have incorrect or incomplete information about sustainability (Camilleri, Larrick, Hossain, & Patio-Echeverri, 2019). However, with an element that attracts consumers' attention, such as texture, consumers can be directed to more sustainable options, even unconsciously. However, it is important to make this texture increase within the acceptable limits of consumers. They are moving away from products with excessive textural complexity.

Whether consumers have information about the product they will buy affects their preferences. Although it did not change the preference outcome in this study, it did change the preference rate.

Restaurants and hotels can benefit from these findings. Since this research is conducted through visuals, service providers can create this effect through their menus or showcases. Based on the results, service providers who want to move towards more sustainable options, especially green restaurants, can use textural differences.

Participants in this study were introduced to a more sustainable alternative to a non-sustainable product that contains beef-derived milk, a widely consumed item in their culture. He measured participants' reactions to this alternative.

This research offered an option, such as texture, to guide consumers towards sustainability. Researchers have not measured if consumers consciously choose sustainable options. It did not evaluate consumers' knowledge on this subject.

Additionally, this work has been limited to making a definitive judgment on energy-related choices.

This study is limited in terms of the number of participants. The study can be repeated by increasing the number of participants.

5. REFERENCES AND NOTES

Bakalar, N. (2012). Sensory science: Partners in flavour. *Nature*.

Banerjee, S., Galizzi, M., John, P., & Mourato, S. (2023). Sustainable dietary choices improved by reflection before a nudge in an online experiment. *Nature Sustainability*.

Boricean, V. (2009). Brief history of neuromarketing. *Bucharest*, 119.

Camilleri, A., Larrick, R., Hossain, S., & Patio-Echeverri, D. (2019). Consumers underestimate the emissions associated with food but are aided by labels. *Nature Climate Change*, 53-58.

Chollet, S., & Valentin, D. (2001). Le degree d'expertise a-t-il une influence sur la perception olfactive? Quelques elements de réponse dans le domaine du vin. *L'année psychologique*, 11-36.

Civille, G. (2011). Food Texture: Pleasure and Pain. *Journal of Agricultural and Food Chemistry*, 59 (5), 1487-1490.

Cui, J., Zhang, X., Reis, S., Wang, C., Wang, S., He, P., . . . Gu, B. (2023). Nitrogen cycles in global croplands altered by elevated CO2. *Nature Sustainability*, 1166-1176.

Daget, N., Joerg, M., & Bourne, M. (1987). Creamy perception I, In model dessert creams. *Journal of Texture Studies*, 18, 367-388.

Diamond, S. (2013). *The visual marketing revolution: 26 rules to help social media marketers connect the dots.* Que Publishing.

Drake, M. (2007). Invited Review: Sensory Analysis of Dairy Foods. *Journal of Dairy Science*, 4925-4937.

Filimonau, V., & Krivcova, M. (2017). Restaurant menu design and more responsible consumer food choice: An exploratory study of managerial perceptions. *Journal of Cleaner Production*, 516-257.

Global Alliance For The Future Of Food. (2023). Future of Food: https://futureoffood.org/ adresinden alındı

Graham, D., Orquin, J., & Visschers, V. (2012). Eye tracking and nutrition label use: A review of the literature and recommendations for label enhancement. *Food Policy*, 378-382.

Griskevicius, V., Tybur, J., & Van den Bersh, B. (2010). Going green to be seen: Status, reputation, and conspicuous conservation. *Journal of Personality and Social Psychology*, 392-404.

Hu, M. (2010). Discovering culinary competency: An innovative approach. *Journal of Hospitality, Leisure, Sport and Tourism Education*, Vol. 9, No. 1 DOI:10.3794/johlste.91.227.

İmram, N. (1999). The role of visual cues in consumer perception and acceptance of a food product. *Nutrition & Food Science*, 99(5), 224-230.

Jin, T., & Kim, J. (2018). What is better for mitigating carbon emissions – Renewable energy or nuclear energy? A panel data analysis. *Science Direct*, 464-471.

Kanwal, K. (2016, 01 11). *Brain tricks to make food taste sweeter: How to transform taste perception and why it matters*. Harvard University: http://sitn. hms. harvard. edu/flash/2016/brain-tricks-to-make-foodtaste-sweeter-how-totransform-taste-perception-and-why-it-matters/ adresinden alındı

Kayıkçıoğlu, H., & Okur, N. (2012). Sera Gazı Salınımlarında Tarımın Rolü. *Adnan Menderes Üniversitesi Ziraat Fakültesi Dergisi, 9 (2)*, 25-38.

Kenning, P., & Plassmann, H. (2008). How neuroscience can inform consumer research. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, 532-538.

Kilcast, D., & Fillon, L. (2001). Understanding consumer requirements for fruit and vegetable texture. *Nutrition & Food Science*, 31(5), 221-225.

Kim, H. (2016). Effect of Food Texture on Consumer Preference: A Review. *Food Quality and Preference*, 52, 15-23.

Kivela, J., & Crotts, J. (2006). Tourism and gastronomy: Gastronomy's ınfluence on how tourists experience a destination. *Journal of Hospitality & Tourism Research*, 30 (3), 354-377.

Koenigstorfer, J., Wasowicz-Kirylo, G., Stysko-Kunkowska, M., & Groeppel-Klein, A. (2013). Behavioural effects of directive cues on front of package nutrition information: The combination matters! *Public Health Nutrition*, 1-7.

Lawless, H., & Heymann, H. (2010). Sensory Evaluation of Food: Principles and Practices. *Food Science Text Series*.

Loebnitz, N., Schuitema, G., & Grunert, K. (2015). Who Buys Oddly Shaped Food and Why? Impacts of Food Shape Abnormality and Organic Labeling on Purchase Intentions. *Psychology & Marketing*, 408-421.

Macdiarmid, J., Douglas, F., & Campbell, J. (2016). Eating like there's no tomorrow: Public awareness of the environmental impact of food and reluctance to eat less meat as part of a sustainable diet. *Appetite*, 487-493.

Madipakkam, A., Bellucci, G., Rothkirch, M., & Park, S. (2019). The influence of gaze direction on food preferences. *Scientific Reports*.

Manic, M. (2015). Marketing engagement through visual content. *Bulletin of the Transilvania University of Brasov. Series V: Economic Sciences*, 89-94.

Meilgaard, M., Carr, B., & Civille, G. (1999). *Sensory evaluation techniques.* United States: CRC press.

Mekonnen, M., & Hoekstra, A. (2010). The Green, Blue and Grey Water Footprint of Farm Animals and Animal Products. *UNESCO-IHE, Volume 1: Main Report, Research Report Series No. 48*, 1-50.

Mouritsen, O., & Styrbaek, K. (2017). *Mouthfeel: how texture makes taste.* Columbia: Columbia University Press.

Murray, J., Delahunty, C., & Baxter, I. (2001). Descriptive sensory analysis: past, present and future. *Food Research International*, 461-471.

Niedziela, M., & Ambroze, K. (2021). The future of consumer neuroscience in food research. *Science Direct*.

OECD. (2006). *Oslo Kılavuzu: Yenilik Verilerinin Toplanması ve Yorumlanması İçin İlkeler.* Paris: OECD.

Palczak, J., Giboreau, A., Rogeaux, M., & Delarue, J. (2020). How do pastry and culinary chefs design sensory complexity? *International Journal of Gastronomy and Food Science*, 19,100182.

Peracchio, L., & Tybout, A. (1996). The moderating role of prior knowledge in schema-based product evaluation. *Journal of Consumer Research*, 177-192.

Raghubir, P. (2011). Visual perception: an overview. *Sensory Marketing*, 201-217.

Richardson, P., Dick, A., & Jain, A. (1994). Extrinsic and intrinsic cue effects on perceptions of store brand quality. *Journal of Marketing*, 28-36.

Rose, D., Heller, M., & Roberto, C. (2019). Position of the Society for Nutrition Education and Behavior: The Importance of Including Environmental Sustainability in Dietary Guidance. *Nutrition Education and Behavior*, 51(1):3-15.

Schiffman, L., & Wisenblit, J. (2019). *Consumer behavior.* New York: Pearson.

Sorensen, L., Moller, P., Flint, A., Martens, M., & Raben, A. (2003). Effect of sensory perception of foods on appetite and food intake: a review of studies on humans. *International Journal of Obesity*, 1152-1166.

Springmann, M., Charles, H., Godfray, J., Rayner, M., & Scarborough, P. (2016). Cobenefits of Global Dietary Change. *Proceedings of the National Academy of Sciences Apr 2016, 113 (15)*, 4146-4151.

Stasi, A., Songa, G., Mauri, M., Ciceri, A., Diotallevi, F., Nardone, G., & Russo, V. (2018). Neuromarketing empirical approaches and food choice: A systematic review. *Food Research International*, 650-664.

Stubbs, R., Johnstone, A., Mazlan, N., Mbaiwa, S., & Ferris, S. (2001). Effect of altering the variety of sensorially distinct foods, of the same macronutrient content, on food intake and body weight in men. *European Journal of Clinical Nutrition*, 19-28.

Szczesniak, A. (2002). Texture is a sensory property. *Food Quality and Preference*, 13(4), 215-225.

Szczesniak, A. (2002). Texture is a sensory property. *Food Quality and Preference*, 215-225.

Şavkay, T. (2000). Tatlı Kitap Türk ve Dünya Tatlıları. *Şekerbank ve Radikal Yayını, İstanbul*.

WCED. (1987). *Our Common Future.* United Nation: WCED.

Wong, R., Kim, S., Chung, S., & Cho, M. (2020). Texture preferences of Chinese, Korean and US consumers: A case study with apple and pear dried fruits. *Foods*, 9(3), 377.

Xu, X., Sharma, P., Shu, S., Lin, T., Ciais, P., Tubiello, F., . . . Jain, A. (2021). Global greenhouse gas emissions from animal-based foods are twice those of plant-based foods. *Nature Food*, 724-732.

Yoon, H., & George, T. (2012). Nutritional information disclosure on the menu: Focusing on the roles of menu context, nutritional knowledge and motivation. *International Journal of Hospitality Management*, 31(4), 1187-1194.

Table 1

Carbon emission and energy values of the samples and changes in comparison to control

Sample Code	Carbon Emissions/per Serving (g CO_2 e)	Changes in Carbon Emissions (%)	Energy Values/per Serving (kcal)	Changes in Energy Values (%)
Caramel Sample				
C	431.11	-	771.29	-
SC1	223.43	48.17	460.74	40.26
SC2	231.25	46.36	621.14	19.47

SC3	274.09	36.42	809.54	-4.96
SC4	277.66	35.59	819.14	-6.20
Pear Sample				
C	431.11	-	771.29	-
SC1	226.80	47.39	455.47	40.95
SC2	247.36	42.62	479.07	37.89
SC3	298.77	30.70	704.43	8.67
SC4	302.34	29.87	714.03	7.42

Table 2

Descriptive statistics of caramel and pear sample for informative and non-informative groups

		CH-C	C-SC1	C-SC2	C-SC3	C-SC4	CH-SC1	CH-SC2	CH-SC3	CH-SC4	SC1-SC2	SC1-SC3	SC1-SC4	SC2-SC3	SC2-SC4	SC3-SC4
Caramel_IM																
	Mean	1.600	1.560	1.640	1.780	1.700	1.580	1.700	1.760	1.740	1.780	1.720	1.660	1.800	1.580	1.500
	STD. Deviation	0.495	0.501	0.485	0.418	0.463	0.499	0.463	0.431	0.443	0.418	0.454	0.479	0.404	0.499	0.505
	Mode	C	SC1	SC2	SC3	SC4	SC1	SC2	SC3	SC4	SC2	SC3	SC4	SC3	SC4	SC3
Caramel_NM																
	Mean	1.460	1.882	1.920	1.880	1.860	1.840	1.960	1.920	1.820	1.900	1.860	1.780	1.580	1.560	1.360
	STD. Deviation	0.503	0.328	0.274	0.328	0.351	0.370	0.198	0.274	0.388	0.303	0.351	0.418	0.499	0.501	0.485
	Mode	CH	SC1	SC2	SC3	SC4	SC1	SC2	SC3	SC4	SC2	SC3	SC4	SC3	SC4	SC3

		CH-C	C-SC1	C-SC2	C-SC3	C-SC4	CH-SC1	CH-SC2	CH-SC3	CH-SC4	SC1-SC2	SC1-SC3	SC1-SC4	SC2-SC3	SC2-SC4	SC3-SC4
Pear_IM																
	Mean	1.600	1.400	1.440	1.640	1.580	1.620	1.560	1.600	1.580	1.540	1.740	1.720	1.720	1.780	1.560
	STD. Deviation	0.495	0.495	0.501	0.485	0.499	0.409	0.501	0.495	0.499	0.503	0.431	0.454	0.454	0.418	0.501
	Mode	C	C	C	SC3	SC4	SC1	SC2	SC3	SC4	SC2	SC3	SC4	SC3	SC4	SC4
Pear_NM																
	Mean	1.460	1.840	1.900	1.960	1.900	1.960	1.920	1.960	1.880	1.700	1.900	1.700	1.840	1.820	1.260
	STD. Deviation	0.503	0.307	0.303	0.198	0.303	0.198	0.274	0.198	0.328	0.463	0.303	0.463	0.370	0.388	0.443
	Mode	CH	SC1	SC2	SC3	SC4	SC1	SC2	SC3	SC4	SC2	SC3	SC4	SC3	SC4	SC3

Table 3

Percentage preference rates of products with more complex textures over products with less complex textures for informative and non-informative caramel and pear groups

	Texture					
Caramel_IM						
	C	***C***				
	CH	60	***CH***			
	SC1	56	58	***SC1***		
	SC2	64	72	78	***SC2***	
	SC3	78	76	72	80	***SC3***
	SC4	70	74	66	58	50
Caramel_NM						
	C	***C***				
	CH	46	***CH***			
	SC1	88	84	***SC1***		
	SC2	92	92	90	***SC2***	
	SC3	88	92	86	58	***SC3***
	SC4	86	82	78	56	36
Pear_IM						
	C	***C***				
	CH	60	***CH***			
	SC1	40	62	***SC1***		
	SC2	44	56	54	***SC2***	
	SC3	96	60	76	72	***SC3***
	SC4	58	58	72	78	56

Pear_NM

C	***C***				
CH	46	***CH***			
SC1	84	96	***SC1***		
SC2	90	92	70	***SC2***	
SC3	64	96	90	84	***SC3***
SC4	90	88	70	82	26

Table 4

Independent samples t-test p value between caramel and pear sample for non-informative and informative groups

	CH-C	C-SC1	C-SC2	C-SC3	C-SC4	CH-SC1	CH-SC2	CH-SC3	CH-SC4	SC1-SC2	SC1-SC3	SC1-SC4	SC2-SC3	SC2-SC4	SC3-SC4
Caramel_IM/ Caramel_NM	n.s.	< .001	< .001	n.s.	0.047	0.006	< .001	0.026	n.s.	n.s.	n.s.	n.s.	0.020	n.s.	n.s.
Pear_IM/ Pear_NM	n.s.	< .001	< .001	< .001	< .001	< .001	< .001	< .001	< .001	n.s.	n.s.	n.s.	n.s.	n.s.	0.003

n.s.:not significant

Table 5

Independent samples t-test p value between samples ın non-informative and informative groups for caramel and pear samples

	C-SC1	C-SC2	C-SC3	C-SC4	CH-SC1	CH-SC2	CH-SC3	CH-SC4	SC1-SC2	SC1-SC3	SC1-SC4	SC2-SC3	SC2-SC4	SC3-SC4
Caramel_IM/ Pear_IM	n.s.	0.035	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	0.009	n.s.	n.s.	n.s.	0.038	n.s.
Caramel_NM/ Pear_NM	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	0.010	n.s.	n.s.	0.005	0.002	n.s.

n.s.: not significant