



Effect of Information on Consumers' Response to Different Food Categories Enriched With Brewer's Spent Grain

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Brewer's spent grain (BSG) has been commonly considered as only a waste product, but recent research on its composition has shown that it can be a functional ingredient. The aim of this study was to analyze consumers' attitude toward different BSG-added food products under informed conditions. BSG-enriched bread, pasta, and chocolate milk were studied exploring two major aspects. First, the eye-tracking technology was used to reveal the effect of different food labels on consumers' attention and purchase intention. Information on sustainability and on BSG varied among the labels under analysis. The best consumers' response occurred when the label displayed: the sustainability logo, fiber source claim, and BSG description. The phrase "Malted Barley" as an appellation of BSG was also analyzed, although it did not produce a significant effect on consumers. Second, consumers' responses to fiber-enriched products and regular products, under informed conditions, were assayed through sensory evaluations. For bread and chocolate milk samples, no significant difference was found in acceptability between the regular and fiber-enriched versions. For pasta, on the other hand, consumers expressed a significant preference in terms of overall liking toward the fiber-enriched version. BSG-enriched products were accepted as much as the regular ones when information was provided, confirming the importance of the fiber source claim and sustainability claims.

Keywords: eye-tracking, by-products, sustainability, food labels, fiber enrichment

INTRODUCTION

Food waste generated by the food industry is a prominent contributor to the environmental impact (Tonini et al., 2018). The increasing consumers' concern about the impact of food production on the environment seems to demand environmentally friendly food products. In fact, consumers' attitude toward sustainability has shifted in the past 5 years, with 85% of consumers globally adopting "greener" purchasing behavior (Simon-Kucher and Partners, 2021). Sustainability has also been recently ranked among the top five value drivers in grocery and household shopping by 50% of consumers in 2021, suggesting sustainability as a new powerful motivation for choosing products.

In this context, one possibility is the use of by-products, like brewer's spent grain (BSG), as a food-grade ingredient, provided that their environmental benefits are clearly conveyed to consumers. Indeed, BSG can be successfully incorporated into food products with numerous advantages to not

TABLE 1 | Factors and factor levels studied on the product label design.

| Label | Factor 1 | Factor 2 | Factor 3 |
|-------|---------------------|-------------------------|-----------------|
| | Sustainability logo | BSG Benefit declaration | BSG appellation |
| 000 | Not present | Not present | BSG flour |
| 001 | Not present | Present | BSG flour |
| 010 | Not present | Not present | Malted barley |
| 011 | Not present | Present | Malted barley |
| 100 | Present | Not present | BSG flour |
| 101 | Present | Present | BSG flour |
| 110 | Present | Not present | Malted barley |
| 111 | Present | Present | Malted barley |

only the environment but also human health. Among these are the following which are distinct: optimization of the resources, minimization of waste, and fortification of food with dietary fiber (Mussatto, 2014; Lynch et al., 2016; Naibaho et al., 2021). As BSG has a high dietary fiber content, which accounts for over 45% of dry matter (Curutchet et al., 2021a), it can be used as a source of fiber.

Nonetheless, the main drawback of including BSG is the fact that adding it to food products introduces major changes in their sensory properties. BSG enrichment has already been associated with changes in texture (Stojceska, 2011; Nocente et al., 2019), color (Petrovic et al., 2017; Nocente et al., 2019), taste (Oluseyi et al., 2011), aroma (Ktenioudaki et al., 2013), and rheological properties (Ktenioudaki et al., 2015; Amoriello et al., 2020) in multiple products including bread, cookies, biscuits, pasta, breadsticks, pizza, and baked snacks. Many of these are undesirable and usually result in less appetizing and tempting products. Thus, formulating BSG-enriched products which are willingly accepted by consumers supposes a big technological challenge.

Extensive research has already been conducted in relation to food choice. Although most of it has focused on sensory food properties, studies have found that the way the food product is perceived by individuals is even more important (Rozin, 2007). New conceptual models have been recently investigated to better understand how healthier and sustainable food choices are made with the aim of shifting to healthier and more sustainable food systems (Chen and Antonelli, 2020). Indeed, food choice is a complex phenomenon where multiple forces interact, including food-internal factors, food-external factors, personal-state factors, and cognitive and sociocultural factors (Chen and Antonelli, 2020).

Research has shown the influence of the front of packaging messages and sustainability claims on consumers' acceptance (Fernqvist and Ekelund, 2014; Biondi and Camanzi, 2019). For instance, Curutchet et al. (2021b) showed that apple pomace cake ranked higher in overall acceptability when bearing the *Sustainable Source of Dietary Fiber* claim than under blind conditions. Meanwhile, the quality of information being conveyed on the label should not be undermined either. While the "by-product" can be related to sustainability and put forward a favorable view, it may also have a negative connotation for consumers (Lambie-Mumford and Silvasti, 2020). Recycled food products may be perceived as unsafe and risky due to

being contaminated or owing to consumers' uncertainty about the manufacturing process (Calvo-Porrall and Lévy-Mangin, 2020). Positioning these products in a favorable way through appropriate communication seems fundamental to gaining consumers' acceptance. Bhatt et al. (2018) studied the effect of labeling on consumers' acceptance of VASP (value-added surplus products) and discovered that the most preferred VASP food description was "upcycled", whereas "resorted" and "rescued" ranked the lowest. Thus, while it is plausible that the declaration of BSG on the label adds differential value to the products, the opposite case can also occur. In other words, the indication of the use of a by-product may not generate an increase in acceptance by consumers (Yang et al., 2020).

Among the different methods used to study the effect of information on consumers' attitude, the eye-tracking technology is at the forefront. It has been widely used in the research field for predicting consumers' food choices (Goyal et al., 2015), discovering how to capture consumer attention to a specific location in the scene (Al-Azawi, 2019) and identifying the most appealing label for a food product (Nemergut and Mokr, 2020). Eye-tracking technology is used to study visual attention as this is reflected in eye movements. Through data analysis, eye movements can then be interpreted to provide insight into the underlying cognitive processes and better understand the decision-making process (Zagermann et al., 2016). By constructing areas of interest (AOIs) on the labels, it is possible to compare food labels and identify what attracts consumers' attention the most (Takahashi et al., 2018). How long each participant looks at an AOI (i.e., *Fixation Time* or *Total Time Viewed*) and the number of times a participant fixes their gaze for an AOI (i.e., *Total Fixations*), are key measurements. The more interested participants are in an AOI, the higher the values for *Total Time Viewed* and *Total Fixation Count* (Samant and Seo, 2016).

The aim of this study was to analyze consumers' attitudes toward sustainable and functional food products belonging to different food categories, under informed conditions. Two main distinct aspects were studied. First, the effect of various label messages on consumers' acceptability and purchase intention was assessed through the eye-tracking technology. Second, the impact of information (i.e., awareness of BSG addition and its benefits) on consumers' sensory acceptability was examined and compared with evaluations carried out under uninformed conditions.

MATERIALS AND METHODS

Preparation of Brewer's Spent Grains

Brewer's spent grain (BSG) was obtained from *Fábricas Nacionales de Cerveza S.A* (Uruguay). Immediately after collection, BSG was refrigerated (<8°C) until drying on the following day at 55°C for 72 h in a convection oven to reach a water content below 5% (Stojceska and Ainsworth, 2008). Dried BSG was milled through 1 and 0.25 mm mesh screens in a Retsch ZM 200 ultra centrifugal mill, packed in polyethylene bags, and kept at room temperature until use.

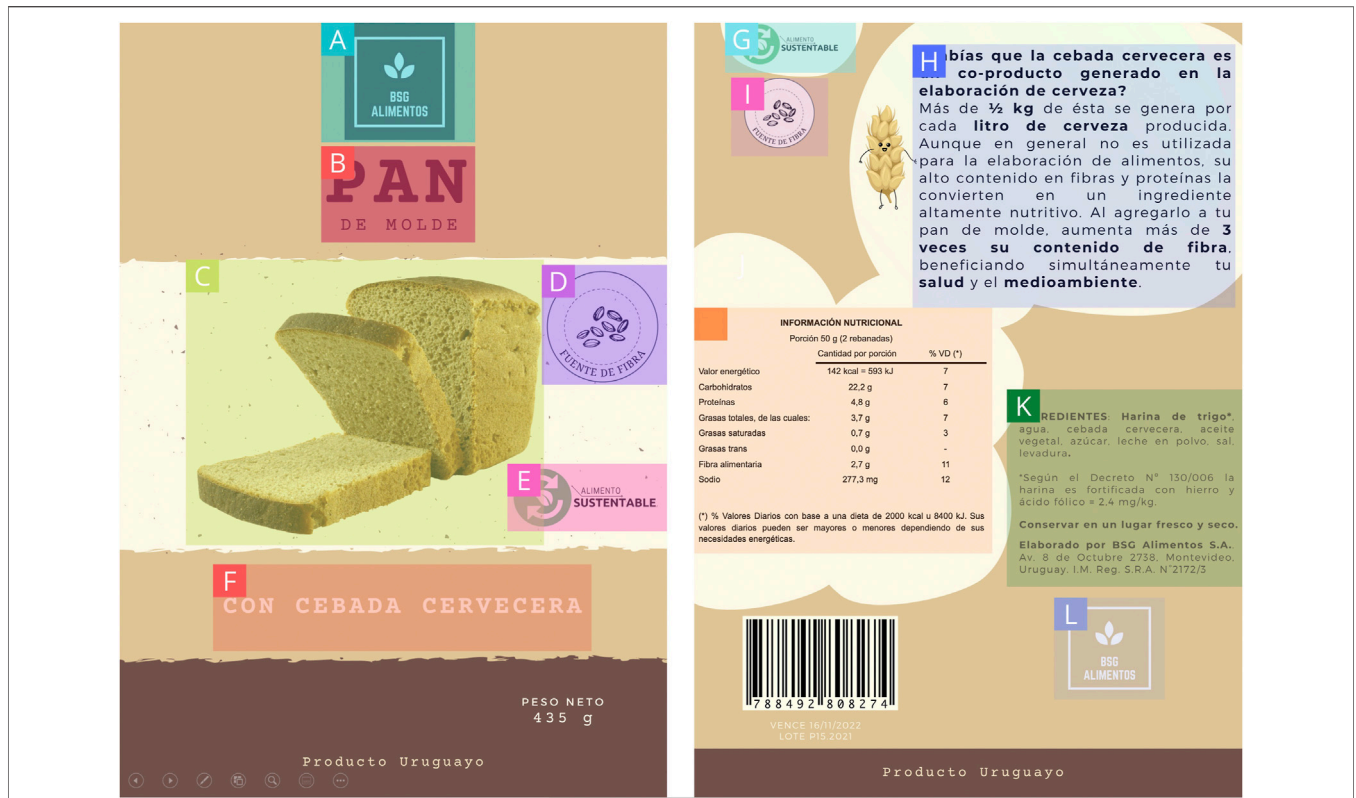


FIGURE 1 | Example of how AOI was defined in one of the labels for fiber-enriched bread. (A) BSG logo; (B) product name; (C) image; (D) fiber logo F; (E) sustainability logo G; (F) BSG Appellation; (G) sustainability logo B; (H) BSG description; (I) fiber logo B; (J) NIP; (K) Ing.; and (L) BSG logo B.

Product Formulation

Consumers' expectations may vary between food products of different categories; therefore, three different products were selected in this study. They were bread and pasta, which could be regarded as utilitarian products, and chocolate- flavored milk, as an example of a hedonic product. BSG was incorporated as a functional ingredient to reach the nutritional claim *Source of Dietary Fiber*, according to Uruguayan legislation (MERCOSUR, 2012), and also comply with Codex Alimentarius (FAO & WHO, 2013) for the claimed source of fiber. The resulting dietary fiber contents for pasta, bread, and chocolate milk were 3.4, 5.9, and 1.3%, respectively.

Non-added BSG formulations for each product category were also developed by replacing the BSG flour with regular flour or milk and used as a control. These were regular bread, regular pasta, and regular chocolate milk. The dietary fiber content of the enriched versions had a 56, 213 and 14% increase, compared with the regular pasta, bread, and chocolate milk. All products were formulated according to Curutchet et al. (2021a) and developed in the pilot plant of Universidad Católica del Uruguay.

Product Labels' Design

Products labels were designed for exclusive use in this investigation using a graphic design platform. Three categorical two-level factors were studied: 1) sustainability logo, 2) brief description of BSG benefits to both consumers

and the environment, and 3) BSG appellation. Thus, this resulted in eight different labels for each product. The factors and factor levels studied are shown in Table 1. A regular sample label was included for the acceptability test (labels in appendix 1).

Eye-Tracking Study

Data were collected in Universidad Católica del Uruguay in three individual sessions—one for each product—from April to May 2021. For every session, 30 regular consumers of each product, male and female participants (44, 60, and 47% female for chocolate milk, pasta, and bread, respectively), ranging between 18 and 70 years old participated in the study. Participants gave informed consent before evaluation.

An optical-tracking Gazepoint GP3 HD eye-tracker was used in this study, which comprised three consecutive tasks. Tasks were performed in a ViewSonic VA 1917A 19" monitor, with the eye-tracker positioned at approximately 0.6 m from participants. Before initiation, the eye-tracker was calibrated for each participant using the nine-point calibration method. Instructions were displayed on the screen. Prior to presenting every image, a fixation cross in the middle of the screen was shown for 3 s to ensure that participants fixed their gaze at this point.

For the first task, participants were shown the eight different labels of one product for 5 s each in a randomized order. After that, the next task comprised displaying the same eight labels in a

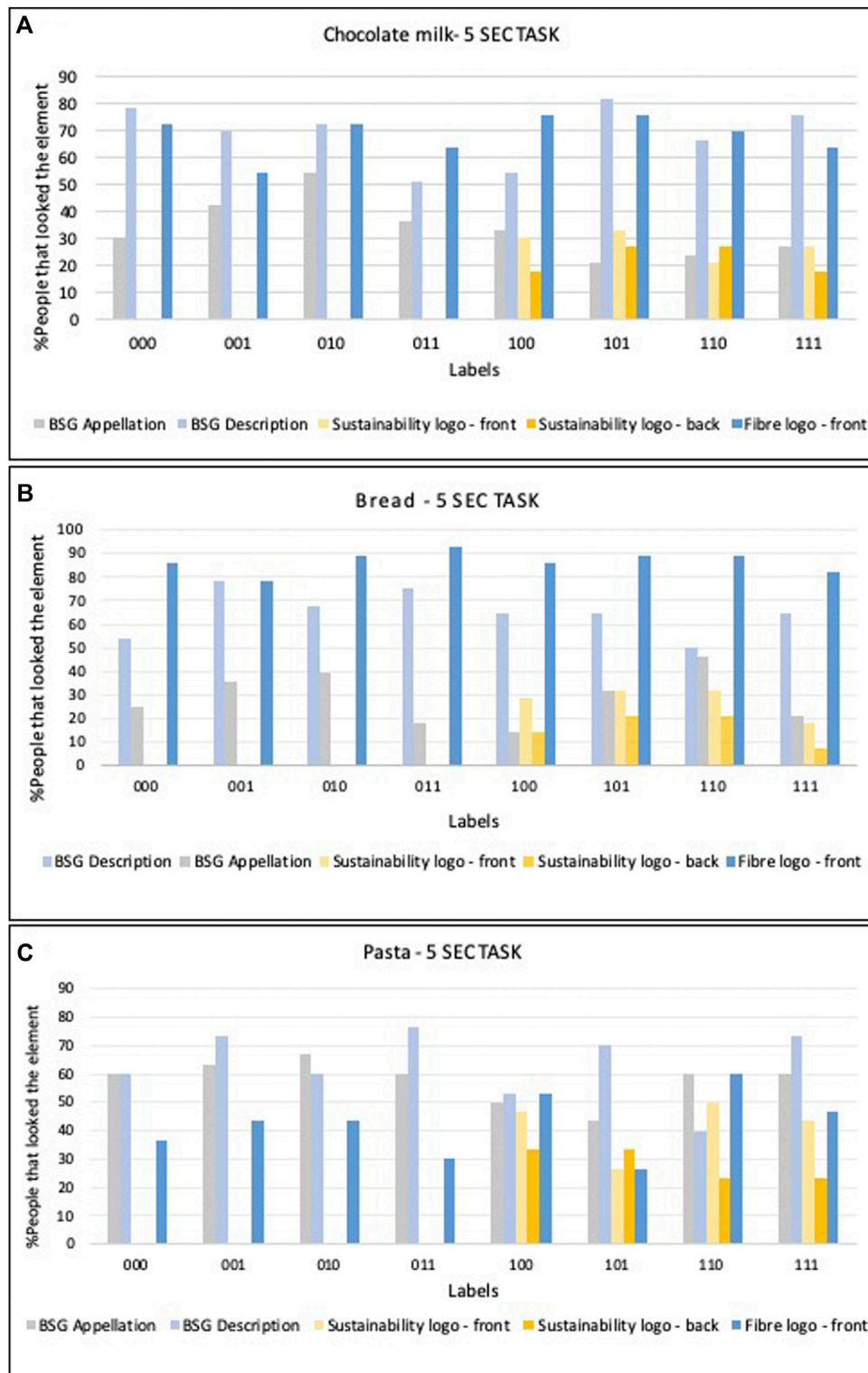


FIGURE 2 | Elements looked at during the 5 s task in each label for (A) chocolate milk, (B) bread, and (C) pasta.

randomized order, but unlimited time was provided for them to explore the labels freely. After each label, a question was made regarding purchase intention (PI) (question A) or perceived

healthiness (PH) (question B). Half of the participants were first asked question A, and the other half were asked question B. Both questions were evaluated according to a seven-point

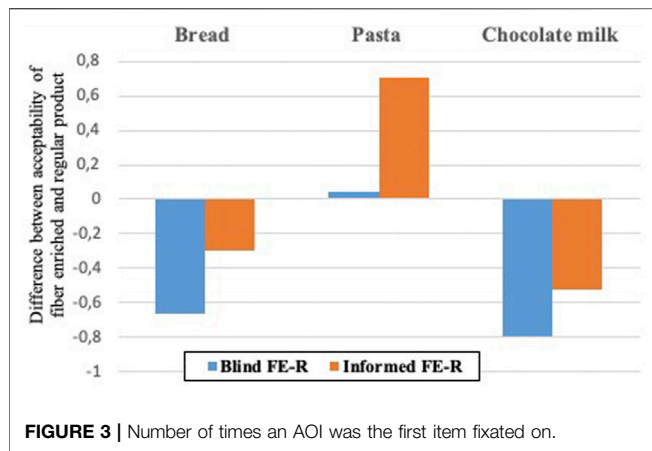


FIGURE 3 | Number of times an AOI was the first item fixated on.

discrete scale (question A: 1- *would definitely not buy*/7- *would definitely buy*; question B: 1- *not healthy at all*/7-*extremely healthy*).

Areas of interest (AOIs) were constructed on the labels to enable interpretation and analysis of results. A maximum of 12 AOIs were defined in each label. See **Figure 1** for details. It should be noted that not every AOI appeared on all food labels as this depended on the factor levels under study (**Table 1**). Eye-tracking metrics included total eye fixation time and first gaze fixation. First gaze fixation was recorded on the AOI where participants looked first.

Sensory Evaluation

Consumers familiar with each product (101, 101, and 100 for bread, pasta, and chocolate milk, respectively), aged between 18 and 70 years old, participated in sensory evaluations under informed conditions to study the acceptability of fiber-enriched bread, pasta, and chocolate milk. Evaluations took place at the Universidad Católica del Uruguay in three different sessions—one for each product—from June to August 2021. Consumers were recruited according to their interest and availability to participate, with the only requirement being that the consumers liked the regular product and felt safe using it. Participants received a consent form and a gift for their participation.

Samples were presented to consumers randomly and with three-digit codes. Each consumer evaluated two samples: regular

(without fiber) and fiber-enriched. Prior to evaluating the product, one label from **Table 1** was selected and shown with each product. Labels for the regular products were also displayed. Participants were asked to rate their overall acceptability using a nine-point hedonic scale (from 1 = extremely disliked to 9 = extremely liked) and purchase intention by a five-point scale (from 1 = would not buy to 5 = would buy).

Data Analysis

For each product, purchase intention and perceived healthiness data were analyzed with the Kruskal–Wallis test at a significance level of 5%, and results from eye-tracker tests were subjected to one-way ANOVA to compare the different labels.

Spearman correlation ($p < 0.05$) was applied to test the relationship between participants' purchase intention and perceived healthiness with total time viewed, total time fixation, time viewed BSG appellation, time viewed BSG description, and time viewed sustainability logo.

The utility value for each factor level on the purchase intention for the total consumer panel was obtained from the partial least squares regression (PLSR). The relative importance was calculated as the effect of each factor on the purchase intention.

Student t-test was applied to acceptability data to determine significant differences ($p < 0.05$) between fiber-enriched and regular samples' acceptability and purchase intention. All statistical analyses were performed by XLSTAT 2021.2.1 software (Addinsoft 2021; New York, NY, USA).

RESULTS AND DISCUSSION

Consumers' Attention to the Label Information

Results from the 5 s eye-tracking task are shown in **Figure 2**. The percentage of consumers that looked at each element at least once (fixations ≥ 1) was counted to size up how many participants paid attention to it. Consumers did not look at the same items in all three products. The BSG description was the item most viewed by consumers, accounting for at least 50% of all products and all labels. The source of fiber logo was observed by more than 60% of consumers in all chocolate milk and bread labels, while between 25 and 60% of participants fixed their gaze on the AOI in pasta labels. BSG appellation was viewed by 24–54% of participants in

TABLE 2 | Spearman correlation coefficients of PI and PH with the eye-tracker metrics.

| Variable | Purchase intention | | | Perceived healthiness | | |
|-----------------------------------|--------------------|--------------|----------------|-----------------------|--------------|----------------|
| | Pasta | Bread | Chocolate milk | Pasta | Bread | Chocolate milk |
| Total time viewed | 0.071 | 0.099 | 0.109 | 0,134 | -0.092 | 0.100 |
| Total fixations | 0.110 | 0.081 | 0.084 | 0,186 | -0.116 | 0.116 |
| Time viewed BSG appellation | -0.080 | 0.098 | -0.014 | 0.051 | -0.046 | 0.081 |
| Time viewed sustainability logo–F | 0.219 | 0.129 | 0.157 | 0.174 | -0.015 | 0.284 |
| Time viewed BSG description | 0.271 | 0.357 | 0.339 | 0.262 | 0.222 | 0.337 |
| Purchase intention | 1 | 1 | 1 | 0.578 | 0.452 | 0.601 |
| Perceived healthiness | 0.578 | 0.452 | 0.601 | 1 | 1 | 1 |

Values in **bold** means significant correlation at the 0.05 level.

TABLE 3 | Part-worth utilities and relative importance of the studied factors for purchase intention regression.

| Factors | Purchase intention (PI) | | | | | |
|---------------------|-------------------------|----------------------|---------------------|----------------------|---------------------|----------------------|
| | Bread | | Pasta | | Chocolate milk | |
| | Relative importance | Part-worth Utilities | Relative importance | Part-worth utilities | Relative importance | Part-worth utilities |
| Sustainability logo | 31% | 0.21 | 35% | 0.17 | 39% | 0.25 |
| BSG description | 69% | 0.47 | 65% | 0.43 | 61% | 0.38 |
| R^2 | 0.978 | | 0.964 | | 0.842 | |

TABLE 4 | Results of sensory evaluations under informed conditions for bread, pasta, and chocolate milk.

| | Informed condition | |
|---------------------------|--------------------|---------------------|
| | Regular (R) | Fiber-enriched (FE) |
| Acceptability | | |
| Bread | 6.52 | 6.22 |
| Pasta | 6.07 | 6.78 |
| Chocolate milk | 6.61 | 6.09 |
| Purchase intention | | |
| Bread | 3.61 | 3.60 |
| Pasta | 3.53 | 3.97 |
| Chocolate milk | 3.40 | 3.30 |

Values in **bold** for same product and condition differ significantly ($p < 0.05$) according to Student's *t* test.

chocolate milk labels, 25–46% in bread labels, and 53–67% in pasta labels. The sustainability logo (front and back) only caught the attention of less than 30% of consumers among the chocolate milk and bread labels. However, for pasta labels, the percentage of participants who looked at that AOI reached 50%. These differences, between pasta and bread/chocolate labels, may be explained by the labels' shape. When the pasta label is horizontal (length/height ratio: 25/8) and does not have a defined figure to focus on, milk and bread labels have a vertical layout (length/height ratio: 70/99), and their images are closer in perceptual terms (Appendix 1). García-Madariaga et al. (2019)'s eye-tracking study showed that packaging with texts and images consistently received more viewed time, more fixations, and less time to the first fixation than packaging without those elements. For literate adults, reading is an automatic process, and therefore, text becomes a powerful visual stimulus, as reflected by the Stroop effect (Megherbi et al., 2018) In relation to images, complete patterns are better recognized than isolated perceptual features since they allow a more efficient interaction with top-down memory-guided predictions (Trapp and Bar, 2015).

The label's element that received the first fixation from consumers for each product was also registered. The distributions of the first fixation among the different elements (Figure 3) were similar for chocolate milk and bread but different for pasta. The fiber logo was the element that caught participants' first fixation most frequently in bread (42%) and chocolate milk (36%). However, in pasta, it was BSG appellation instead (35%). The BSG description received first fixations with a frequency of 7–23% through all products and labels. The sustainability logo was first looked at in less than 5% of the cases, included in others in Figure 3.

García-Madariaga et al. (2019) observed that the image of a product provides quick and easy information to the consumer, and they are the main element capturing consumers' attention as they generally are in a central position and color-contrasted with the label. In the labels tested, the fiber logo was on the front of the package, frequently being where consumers first fixed their gaze on both bread and chocolate milk labels, but for pasta labels, the BSG appellation was located at the center of the label, while the fiber logo was on the right side of it. These results provide evidence that the relative positions of an element on a label attract consumers' attention to different extents. Puerta et al. (2022), in an eye-tracker study with biscuits' labels, found that the number of fixations was particularly high for the biscuit's image and product name as these elements communicate its sensory traits, providing key information that the consumer needs to make the choice decision.

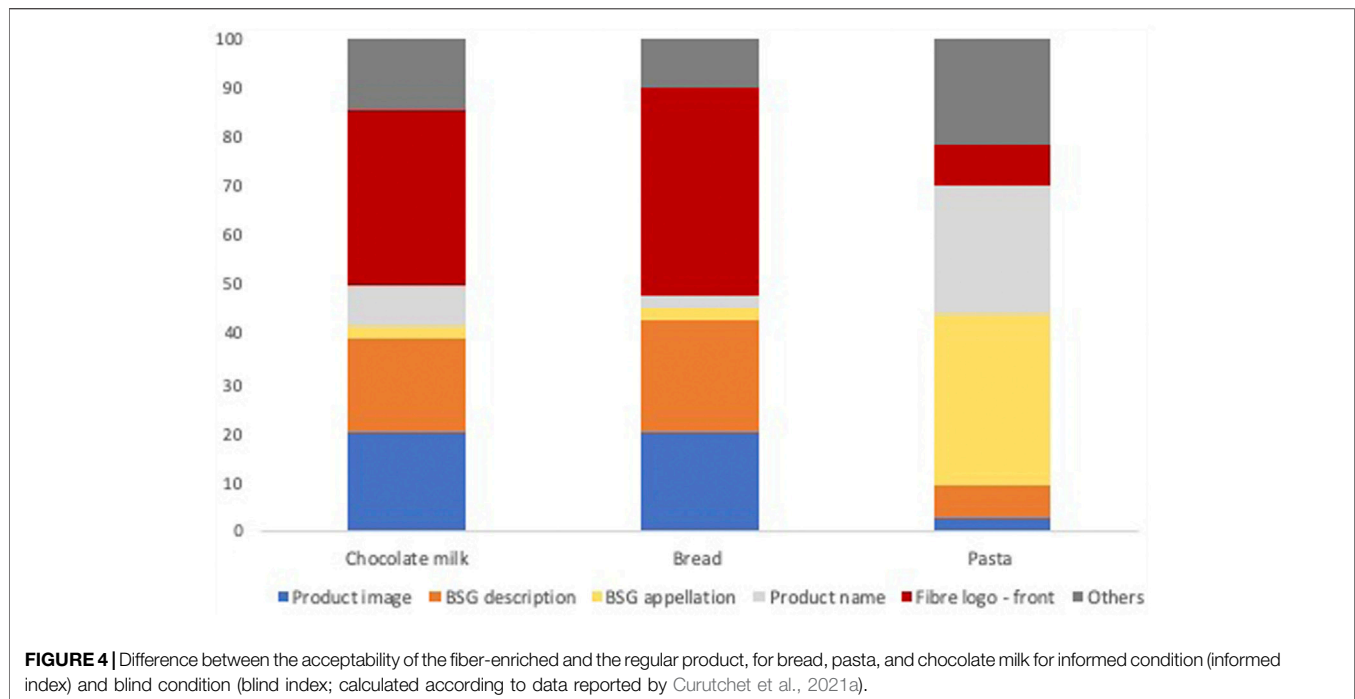
Correlation coefficients between participants' perceived purchase intention, perceived healthiness, total time viewed, total eye fixation and time viewed BSG appellation, sustainability logo, and BSG benefits declaration are shown in Table 2.

For the three products studied, purchase intention was positively correlated with perceived healthiness, both variables being positively influenced by time viewed BSG description and time viewed sustainability logo-F. The fact that the time viewed BSG description positively correlated ($p < 0.05$) with perceived healthiness was expected as the BSG description clearly stated the health benefits of consuming the product under study. As for the positive association between the time viewed sustainability logo-F and perceived healthiness, it may arise from the belief that sustainable diets and healthy diets are synonymous (García-González et al., 2020). Therefore, the more attention consumers directed to the sustainability logo-F, the healthier the product was perceived.

In particular, for pasta, total time viewed and total fixations were positively correlated ($p < 0.05$) with perceived healthiness but not with purchase intention ($p > 0.05$). For bread and chocolate milk, no correlation was found between said measurements and purchase intention or perceived healthiness.

ANOVA results showed that consumers' purchase intention for the three products analyzed varied significantly ($p < 0.05$) with the inclusion of the sustainability logo and the BSG description. BSG appellation was not a significant factor ($p > 0.05$).

Significant factors were included in the purchase intention regression; reports part-worth utilities and relative importance of variables are shown in Table 3.



For the three products studied, respondents increased their purchase intention when the label of the product included the sustainability logo and BSG description, being the latter one the most important with a relative importance of 61–69% among the products studied. In summary, the inclusion of the sustainability logo on the food label may be positive, although it did not catch the attention of all consumers. Lack of interest or lack of knowledge of the meaning of the logo may be the reason behind it. Kaczorowska et al. (2019) found that not all consumers were equally interested in sustainability-labeled food products, which varied based on the consumers' values and traits. Additionally, Samant and Seo (2016) reported that the effects of a sustainability label on the quality perception and acceptability of chicken meat greatly depended on consumers' understanding and credibility of such claims. On the other side, in complex perceptual contexts, highly familiar and semantically loaded stimuli (such as a logo) can be processed through extrafoveal vision, saving resources to process new stimuli (Nuthmann et al., 2019). An extensive description of BSG benefits seems to be the most relevant element to improve the products' perceived healthiness and purchase intention in food enriched with BSG. It should be mentioned that perceived healthiness followed the same tendency with respect to results based on Spearman's positive correlation with purchase intention (Table 2). Apart from this, the inclusion of the source of fiber logo and the label's shape should also be considered to maximize the synergy with the specific information.

Therefore, the sustainability logo and BSG description were included in the labels to investigate the impact of information on the acceptability of bread, pasta, and chocolate milk. As for BSG appellation, although this factor was not significant ($p > 0.05$), malted barley was the selected term to appear on the labels. Recent evidence has shown that consumers prefer sustainable

food products being named as the product it derives from (i.e., malted barley) rather than as the by-product it contains (i.e., BSG) (data not shown). Additionally, the term malted barley was more familiar than the alternative to consumers, who did not fully comprehend the meaning of BSG until after reading the BSG description. Similar results were found by Barbosa et al. (2021) who reported a decrease in acceptability when lacking knowledge of the UFP term (standing for unconventional food plants) displayed on the food product labels.

In conclusion, label 111 (sustainability logo, *Malted barley* as BSG appellation, and BSG description) was the one selected to further continue the investigation for all three products. It should be noted that this label was one of the two that included the most amount of information. According to Koen et al. (2016), providing too much information on the label may confuse consumers; in this case, no information overload seems to have taken place. Thus, information is necessary to help understand and make consumers aware of the benefits associated with BSG-enriched products which are not familiar to consumers. Both, the description of BSG's origin and benefits and the sustainability logo had a positive effect on consumers' perception of all the studied products.

Impact of Information on Product Acceptability

Results of acceptability and purchase intention for bread, pasta, and chocolate milk, under informed conditions, are presented in Table 4. No significant differences ($p > 0.05$) were found in acceptability and purchase intention for bread and chocolate milk between the regular and fiber-enriched versions. However, for pasta, these differences were significant ($p < 0.05$), and the fiber-enriched version overcame the regular one in acceptability and purchase intention.

To evaluate the impact of information on consumer's response, the difference between the acceptability of the fiber-enriched product and the regular product was calculated and expressed as an index (informed index). This index was also calculated for data on acceptability reported by Curutchet et al. (2021a) under blind conditions, for the three products: bread, pasta, and chocolate milk (blind index). Comparisons between the informed index and blind index are represented in **Figure 4**.

For all three products, the informed index outscored the blind index, indicating that information had a positive impact on consumers' acceptability of the fiber-enriched versions of the products. Pasta was the product on which information had the biggest effect (**Figure 4**).

The previous results indicate that information exerted a "halo" effect on consumers in all products as these were better accepted when information was provided, yet no modifications were introduced to their formulations (Biondi and Camanzi, 2019; Li and Dando, 2019). Although some consumers may have inferred the fiber-enrichment under blind conditions and experienced the "halo" effect for bread and pasta (Curutchet et al., 2021a), its effect was intensified with the presence of information. Indeed, the nutritional and environmental claims were clearly displayed on the labels which may have led to a cognitive bias in consumers that modified their sensory evaluation of the products.

The bread was in the middle ground, with consumers approving of this product but not as much as pasta. One possible reason for this may be the fact that rich-in-fiber wholewheat bread are rather popular in the market, meaning that consumers are aware of alternative options, while fiber-enriched pasta is not as popular at least in Uruguay (Pieters et al., 2002). This is also supported by Van Doorn et al. (2021) who reported that sustainable products do better in the market when they are innovative.

In eye-tracking studies, part of the recorded eye movements is driven by the intention or interest of the subject (top-down attention), but there is also an important part of movements driven by the stimulus properties (bottom-up attention) as salient elements receive visual attention even if the consumer is not searching for them (Puerta et al., 2022). A possible cause for the differences found between pasta and bread/chocolate milk is top/down-modulation. In this case, as the pasta itself has no hedonic value, participants are more interested in the health benefit information present on the label.

The main limitation to this work was that the data were obtained in a simulated laboratory setting, which allowed the control of the experimental conditions, but at the same time, it could not fully reflect the real environment. Further studies including more consumers and in a real purchasing context might improve results and get deeper conclusions about consumers' behavior toward sustainable food labeling.

CONCLUSION

This study provided insight into what consumers pay attention to when evaluating BSG-enriched bread, pasta, and chocolate milk. Eye-tracking experiments demonstrated that when the BSG description and sustainability logo were included on the labels, they were

perceived by the consumers, and these caused a positive effect on their purchase intention of all three products. The terms used for BSG appellations in this study do not seem to be important or did not attract the attention of consumers in any of the three products.

The eye-tracking technology was shown to be a powerful tool to understand which aspects consumers pay more attention to on labels. Knowing and using this information when presenting the products to consumers was a suitable strategy to increase the purchase intention of BSG-enriched products. In fact, in this work, BSG-enriched products were more accepted when nutritional and sustainability claims, together with detailed descriptions of them (BSG description) were presented on the label, as evidenced by sensory evaluation results.

Among all three BSG-enriched products, pasta was the product most widely accepted and the one in which information had the most marked effect on consumers' perception, followed by bread and chocolate milk.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ana Fascioli, Universidad Católica del Uruguay. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/frfst.2022.899878/full#supplementary-material>

REFERENCES

- Al-Azawi, M. (2019). The Application of Eye-Tracking in Consumer Behaviour. *Int. J. Eng. Technol.* 8, 83–86. doi:10.14419/ijet.v8i1.12.29469
- Amoriello, T., Mellara, F., Galli, V., Amoriello, M., and Ciccoritti, R. (2020). Technological Properties and Consumer Acceptability of Bakery Products Enriched with Brewers' Spent Grains. *Foods* 9 (10), 1–12. doi:10.3390/foods9101492
- Barbosa, D. M., dos Santos, G. M. C., Gomes, D. L., da Santos, É. M. C., da Silva, R. V., and de Medeiros, P. M. (2021). Does the Label "Unconventional Food Pliyon" Influence Food Acceptance by Potential Consumers? A First Approach. *Heliyon* 7 (4), 1–7. doi:10.1016/j.heliyon.2021.e06731
- 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 (1), 57–63. doi:10.1002/cb.1689
- Biondi, B., and Camanzi, L. (2019). Nutrition, Hedonic or Environmental? the Effect of Front-Of-Pack Messages on Consumers' Perception and Purchase Intention of a Novel Food Product with Multiple Attributes. *Food Res. Int.* 130, 108962. doi:10.1016/j.foodres.2019.108962
- Calvo-Porrall, C., and Lévy-Mangin, J. P. (2020). The Circular Economy Business Model: Examining Consumers' Acceptance of Recycled Goods. *Adm. Sci.* 10 (2), 28–41. doi:10.3390/admsci10020028
- Chen, P. J., and Antonelli, M. (2020). Conceptual Models of Food Choice: Influential Factors Related to Foods, Individual Differences, and Society. *Foods* 9 (12), 1898. doi:10.3390/foods9121898
- Curutchet, A., Serantes, M., Pontet, C., Prisco, F., Arcia, P., Barg, G., et al. (2021a). Sensory Features Introduced by Brewery Spent Grain with Impact on Consumers' Motivations and Emotions for Fibre-Enriched Products. *Foods* 11 (1), 36. doi:10.3390/foods11010036
- Curutchet, A., Trias, J., Tárrega, A., and Arcia, P. (2021b). Consumer Response to Cake with Apple Pomace as a Sustainable Source of Fibre. *Foods* 10 (3), 499. doi:10.3390/foods10030499
- FAO & WHO (2013). GL 23-1997: Guidelines for Use of Nutrition and Health Claims. Codex Alimentarius Commission. Available at: <https://www.fao.org/ag/humannutrition/32444-09f55458abe9a0c3ba01a4502ac36e4.pdf>. Accessed: May 3rd, 2021.
- 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
- García-González, Á., Achón, M., Carretero Krug, A., Varela-Moreiras, G., and Alonso-Aperte, E. (2020). Food Sustainability Knowledge and Attitudes in the Spanish Adult Population: A Cross-Sectional Study. *Nutrients* 12 (10), 3154. doi:10.3390/nu12103154
- García-Madariaga, J., Blasco López, M.-F., Burgos, I. M., and Virto, N. R. (2019). Do isolated Packaging Variables Influence Consumers' Attention and Preferences? *Physiol. Behav.* 200, 96–103. doi:10.1016/j.physbeh.2018.04.030
- Goyal, S., Miyapuram, K. P., and Lahiri, U. (2015). "Predicting Consumer's Behavior Using Eye Tracking Data," in Second International Conference on Soft Computing and Machine Intelligence, Hong Kong, China, 23–24 Nov. 2015, 126–129. doi:10.1109/iscmi.2015.26
- Kaczorowska, J., Rejman, K., Halicka, E., Szczybyło, A., and Górnska-Warsewicz, H. (2019). Impact of Food Sustainability Labels on the Perceived Product Value and Price Expectations of Urban Consumers. *Sustainability* 11 (24), 7240. doi:10.3390/su11247240
- Koen, N., Blaauw, R., and Wentzel-Viljoen, E. (2016). Food and Nutrition Labelling: the Past, Present and the Way Forward. *South Afr. J. Clin. Nutr.* 29 (1), 13–21. doi:10.1080/16070658.2016.1215876
- Ktenioudaki, A., Alvarez-Jubete, L., Smyth, T. J., Kilcawley, K., Rai, D. K., and Gallagher, E. (2015). Application of Bioprocessing Techniques (Sourdough Fermentation and Technological Aids) for Brewer's Spent Grain Breads. *Food Res. Int.* 73, 107–116. doi:10.1016/j.foodres.2015.03.008
- Ktenioudaki, A., Crofton, E., Scannell, A. G. M., Hannon, J. A., Kilcawley, K. N., and Gallagher, E. (2013). Sensory Properties and Aromatic Composition of Baked Snacks Containing Brewer's Spent Grain. *J. Cereal Sci.* 57 (3), 384–390. doi:10.1016/j.jcs.2013.01.009
- Lambie-Mumford, H., and Silvasti, T. (2020). "Introduction: Exploring the Growth of Food Charity across Europe," in *The Rise of Food Charity in Europe: The Role of Advocacy Planning*. Editors H. Lambie-Mumford and T. Silvasti. 1st ed. (Bristol: Bristol University Press), 1–18. doi:10.2307/j.ctvzgb6dt.7
- Li, T., and Dando, R. (2019). Impact of Common Food Labels on Consumer Liking in Vanilla Yogurt. *Foods* 8 (11), 584. doi:10.3390/foods8110584
- Lynch, K. M., Steffen, E. J., and Arendt, E. K. (2016). Brewers' Spent Grain: a Review with an Emphasis on Food and Health. *J. Inst. Brew.* 122 (4), 553–568. doi:10.1002/jib.363
- Megherbi, H., Elbro, C., Oakhill, J., Segui, J., and New, B. (2018). The Emergence of Automaticity in Reading: Effects of Orthographic Depth and Word Decoding Ability on an Adjusted Stroop Measure. *J. Exp. Child Psychol.* 166, 652–663. doi:10.1016/j.jecp.2017.09.016
- MERCOSUR (2012). Res. N° 01/2012: Reglamento técnico MERCOSUR sobre información nutricional complementarias (declaraciones de propiedades nutricionales). Available at: <https://normas.mercosur.int/public/normativas/2581> Accessed: May 3rd, 2021.
- Mussatto, S. I. (2014). Brewer's Spent Grain: A Valuable Feedstock for Industrial Applications. *J. Sci. Food Agric.* 94 (7), 1264–1275. doi:10.1002/jsfa.6486
- Naibaho, J., Korzeniowska, M., Wojdyło, A., Figiel, A., Yang, B., Laaksonen, O., et al. (2021). "The Potential of Spent Barley as a Functional Food Ingredient: Study on the Comparison of Dietary Fibre and Bioactivity," in The 1st International Electronic Conference on Food Science and Functional Foods, 10–25 November 2020, Basel, Switzerland. doi:10.3390/foods_2020-08486
- Nemergut, J., and Mokry, S. (2020). Influence of Packaging Attributes on Perception of Juice: Eye-Tracking Study. *Potr. S. J. F. Sci.* 14, 371–378. doi:10.5219/1267
- Nocente, F., Taddei, F., Galassi, E., and Gazza, L. (2019). Upcycling of Brewers' Spent Grain by Production of Dry Pasta with Higher Nutritional Potential. *LWT* 114 (0023-6438), 108421. doi:10.1016/j.lwt.2019.108421
- Nuthmann, A., De Groot, F., Huettig, F., and Olivers, C. N. L. (2019). Extrafoveal Attentional Capture by Object Semantics. *PLoS One* 14 (5), e0217051. doi:10.1371/journal.pone.0217051
- Oluseyi, A. K., Dawodu, F. A., Ajanaku, O. C., and Nwinyi, O. C. (2011). Functional and Nutritional Properties of Spent Grain Enhanced Cookies. *Am. J. Food Technol.* 6 (9), 763–771. doi:10.3923/ajft.2011.763.771
- Petrovic, J., Pajin, B., Tanackov-Kocic, S., Pejin, J., Fistes, A., Bojanic, N., et al. (2017). Quality Properties of Cookies Supplemented with Fresh Brewer's Spent Grain. *Food Feed Res.* 44 (1), 57–63. doi:10.5937/ffr1701057p
- Pieters, R., Warlop, L., and Wedel, M. (2002). Breaking through the Clutter: Benefits of Advertisement Originality and Familiarity for Brand Attention and Memory. *Manag. Sci.* 48 (6), 765–781. doi:10.1287/mnsc.48.6.765.192
- Puerta, P., Laguna, L., Tárrega, A., and Carrillo, E. (2022). Relevant Elements on Biscuits Purchasing Decision for Coeliac Children and Their Parents in a Supermarket Context. *Food Qual. Prefer.* 98, 104496. doi:10.1016/j.foodqual.2021.104496
- Rozin, P. (2007). "Food Choice: an Introduction," in *Understanding Consumers of Food Products*. Editors L. Frewer and H. van Trijp (Florida: Woodhead Publishing), 3–29. doi:10.1533/9781845692506.1.3
- Samant, S. S., and Seo, H.-S. (2016). Quality Perception and Acceptability of Chicken Breast Meat Labeled with Sustainability Claims Vary as a Function of Consumers' Label-Understanding Level. *Food Qual. Prefer.* 49, 151–160. doi:10.1016/j.foodqual.2015.12.004
- Simon-Kucher and Partners (2021). Global Sustainability Study: Consumers Are Key Players for a Sustainable Future. Available at: https://www.simon-kucher.com/sites/default/files/studies/Simon-Kucher_Global_Sustainability_Study_2021.pdf Accessed: February 26th, 2022.
- Stojceska, V., and Ainsworth, P. (2008). The Effect of Different Enzymes on the Quality of High-Fibre Enriched Brewer's Spent Grain Breads. *Food Chem.* 110 (4), 865–872. doi:10.1016/j.foodchem.2008.02.074
- Stojceska, V. (2011). "Dietary Fiber from Brewer's Spent Grain as a Functional Ingredient in Bread Making Technology," in *Flour and Breads and Their Fortification in Health and Disease Prevention*, London: Academic Press, 171–181. doi:10.1016/b978-0-12-380886-8.10016-9
- Takahashi, R., Todo, Y., and Funaki, Y. (2018). How Can We Motivate Consumers to Purchase Certified Forest Coffee? Evidence from a Laboratory Randomized Experiment Using Eye-Trackers. *Ecol. Econ.* 150 (0921-8009), 107–121. doi:10.1016/j.ecolecon.2018.04.010

- Tonini, D., Albizzati, P. F., and Astrup, T. F. (2018). Environmental Impacts of Food Waste: Learnings and Challenges from a Case Study on UK. *Waste Manag.* 76, 744–766. doi:10.1016/j.wasman.2018.03.032
- Trapp, S., and Bar, M. (2015). Prediction, Context, and Competition in Visual Recognition. *Ann. N.Y. Acad. Sci.* 1339 (1), 190–198. doi:10.1111/nyas.12680
- Van Doorn, J., Risselada, H., and Verhoef, P. C. (2021). Does Sustainability Sell? The Impact of Sustainability Claims on the Success of National Brands' New Product Introductions. *J. Bus. Res.* 137, 182–193. doi:10.1016/j.jbusres.2021.08.032
- Yang, Q., Shen, Y., Foster, T., and Hort, J. (2020). Measuring Consumer Emotional Response and Acceptance to Sustainable Food Products. *Food Res. Int.* 131, 108992. doi:10.1016/j.foodres.2020.108992
- Zagermann, J., Pfeil, U., and Reiterer, H. (2016). "Measuring Cognitive Load Using Eye Tracking Technology in Visual Computing," in Proceedings of the Beyond Time and Errors on Novel Evaluation Methods for Visualization - BELIV '16, Baltimore MD USA 24 October 2016, 78–85. doi:10.1145/2993901.2993908

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