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Effect of sight on the evaluation and acceptance of new products: Breaded nuggets with breadcrumbs and a new seasoning

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ABSTRACT

The main aim of this study is to examine the influence of chicken nugget color and appearance on the overall acceptance rates and responses of a panel of consumers. Fifty blindfolded and fifty-two non-blindfolded panelists tasted the nuggets. They evaluated their Overall Liking (OL) and their perceptions of the sensory properties of chicken nuggets with no seasoning and chicken nuggets coated in breadcrumbs with 10% and 25% of a red pomace seasoning, a by-product of red winemaking. Just-About-Right (JAR) scales and Penalty Analysis (PA) were then used to determine the adequacy of the sensory attributes that the consumers had attributed to the products. Furthermore, purchase intention was also studied. The red pomace seasoning, regardless of the quantity that was used, darkened the nugget coatings. No effect of color on OL was observed when comparing the responses of the blindfolded and the non-blindfolded consumers. Their purchase intention decreased in proportion to the increased amount of seasoning added to the breadcrumbs. However, PA suggested that nuggets coated in breadcrumbs with 10% red pomace seasoning could after some reformulation be successfully marketed.

1. Introduction

Sight is a driving force behind our assessment of food products and can often modify an impression perceived through the other four senses (Damaziak et al., 2019; Hurling & Shepherd, 2003; Spence, Okajima, Cheok, Petit, & Michel, 2016).

Research has indicated that color can influence the perceived flavor, odor, and intensity of taste in foods (Wadhera & Capaldi-Phillips, 2014). Several studies have shown a clear link between color and flavor perception in food (Spence, 2015; Spence & Velasco, 2018). For instance, the coloration of a white wine with red wine anthocyanins induced differences in flavor responses between the colored and the original white wines, proving that visual experience can also influence taste, even though the taste buds are the main sensory organ (This, 2007). Therefore, to deepen our knowledge of food color and its influence on consumer response, products with a significant color change should be selected.

In addition, prior to consumption, color can shape taste-related expectations and thereby influence judgments as to the acceptability of food, which can ultimately influence food choice and consumption (Koch & Koch, 2003; Spence et al., 2010; Walsh, Toma, Tuveson, & Sondhi, 1990). Schlosser (2001) showed that color significantly influenced food acceptance. In this study, participants were taken to a specially lit room with colored lights and given a plate of French fries and steak. While the food appeared to have the usual flavors, some participants felt ill when they saw that the steak was blue and the fries were green. Their response can be linked to an inherent dislike for certain food colors, *i.e.*, blue, an uncommon color in natural foods that is sometimes a sign of spoilage. People might anticipate that some blue-colored foods taste unpleasant or are unhealthy (Dias et al., 2012), as consumers frequently use color as a cue to evaluate the quality of food and drinks (Spence et al., 2010). Some colors are better suited to specific foods and beverages than others. Therefore, when the food industry develops new products by adding new ingredients that significantly change the color of traditional products, it must research and understand how a color change will influence the sensory quality of the final product.

So, the simplest way to ascertain the extent to which sight may modify the perception of impressions based upon other senses and therefore the acceptability of a food could be through a group of blindfolded panelists. Nevertheless, the so-called "visual memory" should also be considered (Geraldo & Silva, 2012). Consequently, the responses of the same panelists –both blindfolded and not blindfolded – could yield false results (Damaziak et al., 2019).

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Out of the variety of meat products that could have been included in this study, the choice of chicken nuggets was based on the growing consumption of poultry products within both developing and developed countries (Thornton, 2010). In addition, natural ingredients with product formulations containing bioactive compounds, due to the recent high demand for functional foods, are investigated. A seasoning obtained from red wine by-products has been proposed as a natural and healthy ingredient that can be added to chicken nugget breadcrumb coatings, due to its high content of phenolic compounds (García-Lomillo & González-SanJosé, 2017). Likewise, another advantage of this seasoning is its fiber content, which could increase the fiber content in products to which it may be added, as reported by Ortega-Heras, Gómez, de Pablos-Alcalde, and González-Sanjosé (2019) in whole-wheat muffins containing 10 and 20% of white and red grape pomace product.

Red pomace seasoning is rich in anthocyanin pigments that darken the product into which they are incorporated, which could modulate consumer opinions and the intention to try out these new products. In that sense, Ortega-Heras et al. (2020), in a study of chicken breasts marinated with a similar seasoning, identified two groups of consumers, one of which was more willing to try out and to accept new products whose color showed very significant change. New products of that sort, despite their significantly modified appearance, could therefore find a market. Moreover, the application of the grape pomace seasoning in foodstuffs may modify the other sensory attributes (García-Lomillo & González-SanJosé, 2017). Therefore, when new foods or new food recipes are developed using grape pomace seasoning, it would be necessary to evaluate overall acceptance rates and to determine an acceptable dose that hardly affects the Overall Liking (OL) of most consumers. Among the sensory techniques, Just-About-Right (JAR) scales and attribute liking questions are highlighted to obtain information on consumer perceptions (Popper, Rosenstock, Schraidt, & Kroll, 2004). Likewise, the use of Penalty Analysis (PA) improves the understanding of the attributes that most affect liking ratings (Plaehn & Horne, 2008).

In this context, the main objective of this study was to examine whether sight could affect the overall acceptance rates of consumers and their responses. A secondary objective was to evaluate the perceived sensory properties of breaded chicken nuggets and the effect of an added seasoning, obtained from red winemaking by-products. To do so, sensory analyses using JAR scales with both (blindfolded and non-blindfolded) consumers were conducted.

2. Materials and methods

2.1. Experimental design and material

Chicken nuggets coated in three different breadcrumb formulations were deep fried: C, control formulation, 100% commercial breadcrumb batter; S10, control formulation with 10% seasoning; S25, control formulation with 25% seasoning.

Chicken meat was obtained from deboned skinless chicken breasts that were purchased in a local market (Grupo SADA, S.A., Madrid). The chicken meat (80%) was mixed with the usual ingredients used in the formulation of commercial nuggets: ice (10%), potato starch (7%) (Doscadesa 2000; S.L., Murcia, Spain), albumin (2%) (Huevos Guillen, S. L., Valencia, Spain), and salt (1%) (Salinas del Odiel, S.L., Huelva, Spain). Beaten eggs were used before breading. According to the formulation, the breadcrumb was added with seasoning: (C: 0%; S10: 10%; S25: 25%). Sunflower oil was used for the frying.

The seasoning was obtained from red winemaking byproducts applying a patented process CCP: ES2524870 (González-SanJosé, García-Lomillo, Del Pino-García, Muñiz-Rodríguez, & Rivero-Pérez, 2015). Specifically, the seasoning used in this study was obtained from red pomace. Its physicochemical composition was similar to that of other seasonings previously prepared by our research group (García-Lomillo, González-SanJosé, Del Pino-García, Rivero-Pérez, & Muñiz-Rodríguez, 2014).

2.2. Preparation of nuggets

The chicken meat was first ground in a mincer (Moulinex A320R1, Moulinex, Barcelona, Spain) with ice. Subsequently, the meat and the other ingredients (potato starch, albumin, and salt) were mixed for 10 mins until a homogeneous mixture was obtained. The chicken nugget samples were formed into circular shapes (55 × 15 mm), each weighing 45 ± 3 g. The samples were dipped in the beaten egg and then coated in the different breadcrumb formulations (C, S10, S25). The breaded chicken nuggets were then deep fried (Jata FR679, Electrodomésticos JATA, S.A., Tudela, Spain) in sunflower oil at 180 °C for 210 s. Under those conditions, the temperature at the center of the nugget was 74 °C.

2.3. Color

Color was measured using a Minolta CM-2600d spectrophotometer (Konica Minolta Sensing Inc., Osaka, Japan) (Illuminant D 65, 10° viewing angle). The CIELab system was applied, lightness (L*), green-red (a*), and blue-yellow (b*) were measured. Two measurements were taken in the analysis on each surface of three different nuggets for each formulation (n = 6).

2.4. Consumer study

The samples were assessed in a standardized tasting room (ISO 8589, 2007). One hundred and two regular consumers of chicken (at least once a week) – students, professors and administrative staff from the Faculty of Science (Burgos University, Burgos, Spain), aged between 17 and 55 years old, 77% of whom were female – took part in the sensory evaluation of the nuggets.

Two different sessions were held. The first session consisted of blindfolded consumers (50) to avoid the influence of sight on the evaluation of other sensory attributes. Blindfolded consumers wore an eye mask that covered their eyes. A research assistant helped the consumer to taste each nugget and recorded the responses on a piece of paper. The second session consisted of 52 other consumers who participated, as usual, in a visual situation.

The consumers evaluated three chicken nuggets (one for each formulation) in a single session. As previously explained, the nuggets were fried in sunflower oil at 180 °C for 210 s, reaching 74 °C in the center of the nugget. They were then placed on a warming table at 45 °C ± 1.5 °C until being served to the consumers. Samples were presented one at a time, in random order, following a balanced complete block experimental design. The samples were coded with random three-digit numbers. Consumers could rinse out their mouths with water between samples.

The OL for each sample was scored on a nine-point hedonic scale (1 = “dislike extremely”; 9 = “like extremely”). Consumers also evaluated the adequacy of five attributes: “crispness”, “juiciness”, “oiliness”, “saltiness”, and “chicken flavor”, using JAR bipolar scales. In addition, the consumers who saw the samples evaluated the “surface color”. JAR scales are used in studies with consumers to establish whether a particular attribute is perceived in a product at excessive, scarce, or acceptable levels. The extreme ends of the scale represent the level of an attribute that moves away from the ideal theoretical point in opposite directions, whereas the central point is the ideal or acceptable one (Rothman, 2007). In this study, the adequacy of the attribute levels of each sample was scored on a five-point JAR bipolar scale (from 1 = “much less” to 5 = “much more” with middle value 3 = “just about right”). PA was conducted by transforming the initial five-point scale into a three-point scale. To do so, the responses “much less” and “less” were grouped into a single group labeled “much less”, and the responses “more” and “much more” were grouped into a single group labeled “much more” (Ares & Varela, 2018; Popper, 2014; Rothman, 2007). Furthermore, all consumers were asked to respond either “yes”’ or “no" to the question of whether they would be willing to buy each product.

The reason for asking the blindfolded consumers about their purchase intention was to determine whether it solely depended on the product's color and appearance or, on the contrary, whether there was another sensory parameter that played a key role in determining purchase intention towards the nuggets in this study. For example, whether a low perception of chicken flavor or juiciness would carry more weight than the pronounced darkening when determining the purchase of the nuggets in this study. The questionnaire was presented in a printed format on paper.

2.5. Data analysis

The results of color and OL scores were presented as the average ± standard deviation of the different replicates. An ANOVA test, at a significance level of $p = 0.05$, was performed to verify whether there were any statistically significant effects of the seasoning used in the formulations (C, S10 and S25). The LSD (Least Significant Difference) test was performed to evaluate statistically significant differences between samples. An Independent Groups design was proposed to evaluate the impact of the test conditions (blindfolded *vs.* non-blindfolded), and the *t*-test was used to compare the means of the two conditions. The Statgraphics Centurion XVII.I software program (Statgraphics Technologies, Inc., The Plains, USA) was used.

The JAR results were analyzed and a PA was performed to identify potential directions for product improvement and to determine the most penalizing attributes in terms of liking (Plaehn & Horne, 2008). The penalty score or Drop In Overall Liking (DIOL) was calculated as OL (JAR) minus OL(non-JAR). An attribute was considered susceptible to modification when 20% or more of the responses were situated at one of the extremes of the JAR scale (Xiong & Meullenet, 2006) and the DIOL was over 1 (Laguna, Varela, Salvador, & Fiszman, 2013; Popper, 2014). The respondent percentages (x-axis) were plotted against the DIOL (y-axis); so, an average DIOL of 1.0 or more, mentioned by more than 20% of consumers, was considered a threshold for a meaningful DIOL of an attribute (Popper, 2014). XLSTAT software (Lumivero, Denver, USA) was used to process the JAR and PA results.

3. Results and discussion

3.1. Color

The addition of the seasoning to the breadcrumb modified the appearance of the nuggets, mainly affecting the color, with differences perceived by the human eye (Fig. 1), and that were quantified through the instrumental color measurement (Table 1). Breading crusts with seasoning were darker (lower L* values), although no dose effect was observed on this parameter. Furthermore, the use of seasoning reduced the redness (lower values of a*) and the yellowness (lower b* values) with dose-dependent effects. These results corresponded with the color change of the breading, shifting from a light brown to a dark brown tone (Fig. 1). However, it is important to remark that there was no change in the color of the chicken meat. A similar darkening effect had previously been observed in beef burgers (García-Lomillo, Gonzalez-SanJose, Del Pino-García, Ortega-Heras, & Muñiz-Rodríguez, 2017), which was attributed to the contribution of intensely colored phenolic compounds present in the seasonings.

Fig. 1. Color of nuggets. C: control nugget; S10: nugget with 10% red pomace seasoning added to the breadcrumb; S25: nugget with 25% red pomace seasoning added to the breadcrumb. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

3.2. Sensory analysis

3.2.1. Liking

The OL score for each nugget (Table 2) showed some differences in consumer responses to the products at first sight. Thus, the OL values attributed to the control nuggets and those with 10% seasoning added to the batter were higher among the blindfolded consumers than the values attributed to the nuggets with 25% seasoning ($p < 0.05$). In contrast, when consumers viewed the products, both nuggets with red pomace seasoning (S10 and S25) received lower OL values than the control nuggets ($p < 0.05$). It should be highlighted that there were no significant differences ($p > 0.05$) between the OL scores of each formulation among the (blindfolded and non-blindfolded) consumers. The results revealed no negative effect associated with blindfolds and that there was no risk of potential false positive results, contrary to the suggestion of Damaziak et al. (2019). Instead, the higher scores for the control sample among the non-blindfolded consumers appeared to indicate some reward for the "expected/usual" color, which explained why (in this case) there was a significant difference between the control sample and the formulations with seasoning.

Given all of the above, the OL results obtained in this study under the blindfolded condition lend support to the idea that food perception depends on the integration of multisensory signals (Prescott, 2015; Spence, 2016; Zampini, Wantling, Phillips, & Spence, 2008).

It is worth noting that the breading formulation with the highest concentration of seasoning received the lowest OL scores among both (blindfolded and non-blindfolded) consumers. A result that is associated with the modification of visual sensory attributes produced by high levels of the seasoning, among other attributes, as discussed below.

3.2.2. Attribute adequacy

The results of the JAR scales are expressed as percentages of responses for each category and for each attribute evaluated in each nugget (Fig. 2).

The scores of the blindfolded consumers (Fig. 2a) indicated that they perceived the nuggets coated with breadcrumbs containing red pomace seasoning (S10 and S25) as having far less juiciness and with much less chicken flavor intensity. Results that were due to the seasoning flavor, which partially masked the flavor of the chicken. In a preliminary sensory analysis with untrained panelists, Lau and King (2003) also found a light masking in the flavor of turkey meat with added grape seed extract. Likewise, it was reported in another study that a higher grape pomace concentration in chicken meat could have adversely affected flavor (Selani et al., 2011). The lesser perception of juiciness, is probably due to the dry mouthfeel produced, among other factors, by the polyphenols and the fiber provided by the seasoning. Polyphenols, especially tannins, can bind to food proteins and potentially alter the texture of the food (Zhang, Huang, Wang, Wan, & Wang, 2024). They can also contribute to a sensation of astringency or dryness in the mouth (Soares et al., 2020). Moreover, fiber has the ability to improve water retention (Gómez, Janardhanan, Ibañez, & Beriain, 2020). If a significant amount of fiber is added to a meat product, it can decrease the amount of available water within the product, which could also result in less juiciness. A decrease of juiciness due to the presence of fiber was noted by Nardoia et al. (2018) in chicken patties obtained from birds fed diets containing grape pomace, in fiber added chicken meat rolls and patties (Mehta, Ahlawat, Sharma, Yadav, & Arora, 2013), dietary fiber-enriched chicken sausage (Yadav, Malik, Pathera, Islam, & Sharma, 2016), and beef patties containing okara power (Turhan, Temiz, & Sagir, 2009). Oiliness and

Table 1
Color of the chicken nuggets: control (C) and with 10 % and 25 % red pomace seasoning (S10 and S25) added to the breadcrumb.

Sample	L*	a*	b*
C	35.8 ± 3.4 [b]	11.8 ± 1.9 [c]	19.8 ± 3.3 [c]
S10	24.6 ± 2.1 [a]	3.71 ± 1.13 [b]	5.05 ± 2.28 [b]
S25	23.2 ± 1.8 [a]	2.07 ± 0.84 [a]	1.86 ± 1.50 [a]

Different letters within a column indicate statistically significant differences between the samples ($p < 0.05$, LSD test).

Table 2
Overall liking (OL) (mean ± standard deviation) of the chicken nuggets among blindfolded (n = 50) and non-blindfolded (n = 52) consumers: control (C) and with 10 % and 25 % red pomace seasoning (S10 and S25) added to the breadcrumb.

Condition	Samples		
	C	S10	S25
Blindfolded	6.70 ± 1.62 [b1]	6.44 ± 1.61 [b1]	5.63 ± 1.61 [a1]
Non-blindfolded	7.11 ± 1.07 [b1]	6.36 ± 1.18 [a1]	6.12 ± 1.33 [a1]

Letters compare formulations and numbers blindfolded/non-blindfolded evaluation. Different letters or numbers within a row or column, respectively, indicate statistically significant differences between the samples ($p < 0.05$, LSD test for formulations, *t*-test for blindfolded/non-blindfolded evaluation).

saltiness were similarly evaluated in all three types of nuggets, with high percentages of JAR responses, ranging between 56-66% and 64–78% for oiliness and saltiness, respectively. Moreover, differences were observed in the results of crispness. The percentage of "much less" responses for the crispness attribute increased as the percentage of seasoning increased. As the seasoning had a high fiber content, it retained more water, which made the nugget coating less crispy. Likewise, there were~~with~~ percentages of responses at both extremes of the scale exceeding 20% in the case of the S25 nugget. This segmentation of consumer responses was also found in the evaluation of the juiciness of the seasoned nuggets (S10 and S25), yielding results that could be due to disagreements between consumers over the ideal levels of such attributes (Popper, 2014).

The results of the evaluation by the non-blindfolded consumers (Fig. 2b) indicated that a high percentage (>90%) considered both seasoned nuggets too dark. The addition of seasoning to the final product explained the dark color, as previously mentioned in connection with the instrumental color results. Moreover, the use of seasoning did not notably alter the assessment of the rest of the parameters compared to the control nuggets, except for crispness, which led to~~a higher~~ an increase in the percentage of "much less" responses related to the seasoned nuggets.

Comparing the results from both tasting conditions, it could be indicated that, in general, the percentage of JAR responses to seasoned nuggets (S10 and S25) was higher among the non-blindfolded than among the blindfolded consumers. In contrast, the percentage of JAR responses for the attributes oiliness, saltiness, and chicken flavor of the control nuggets was lower among the non-blindfolded than among the blindfolded consumers. Moreover, regardless of which consumers (blindfolded or non-blindfolded) saw the samples; the JAR chicken flavor percentages were higher for the S10 nuggets than for the control sample. Those results appeared to indicate that the excessive color of the seasoned nuggets had no negative effect upon the assessment of the other sensory characteristics under evaluation. They may be contrasted with the results described by Koch and Koch (2003), who indicated that certain colors may produce preconceived ideas about flavor, making a particular food or drink more or less desirable.

Considering that there were response percentages greater than 20% for "much less" or "much more", a PA was used (Plaehn & Horne, 2008) to determine which attributes had greater influence on the final

Fig. 2. Percentages of responses within each category ("much less", blue color; "JAR", red color; "much more", green color) for each attribute of the nuggets that was evaluated: (a) blindfolded ($n = 50$); (b) non-blindfolded ($n = 52$) consumers. Formulations: C: control nugget; S10: nugget with 10% red pomace seasoning added to the breadcrumb; S25: nugget with 25% red pomace seasoning added to the breadcrumb. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

acceptability of the product, and to identify potential directions for reformulation.

3.2.3. Penalty analysis

The results were analyzed by PA where an attribute was considered significant when the response percentage was higher than 20% (Xiong & Meullenet, 2006) and the mean drop was higher than 1 (Laguna et al., 2013; Popper, 2014). A nugget with attributes in the upper right-hand corner of the penalty plot is considered worse than one with attributes located in the lower left-hand corner (Laguna et al., 2013). A nugget with attributes located in the lower left area of the penalty plot means that only a few consumers say the attribute level is not right and the impact on OL is small, so, it would be the "desired nugget".

The penalty analyses of the responses of the blindfolded consumers (Fig. 3a) yielded similar results to those of the C and S10 nuggets, but different results from those of the S25 nugget. Regarding the results of the C and S10 nuggets, the penalties exceeding a value of 1 had response percentages below 20%; therefore, their effect on acceptability was not significant. However, in the case of the S25 nugget, the juiciness, crispness, and chicken flavor parameters had values over 1 and response percentages over 20%; it could therefore be asserted that those parameters had a significant influence on acceptability.

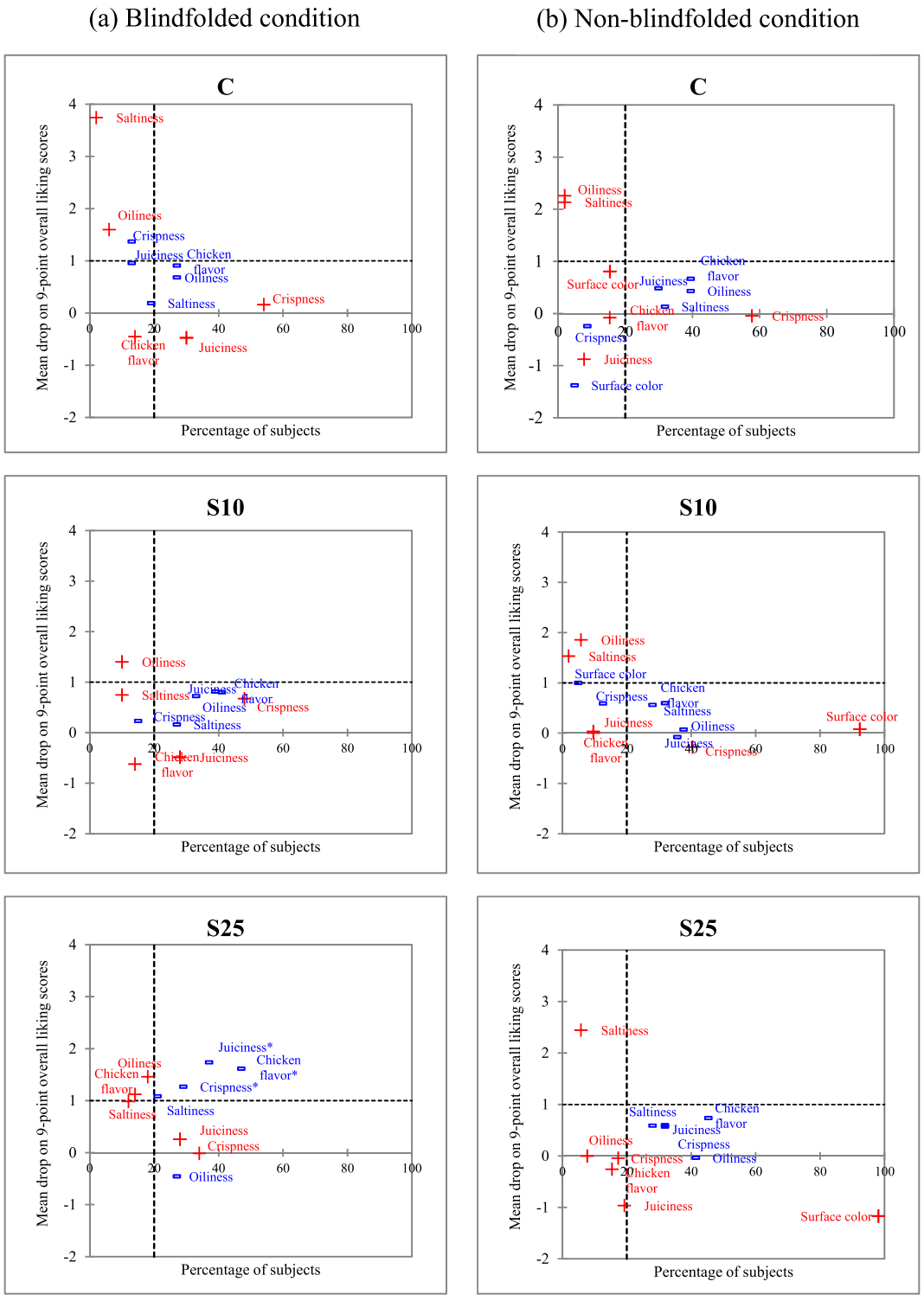

Fig. 3. Penalty analysis. Representation of significant penalties (drops in liking) by the proportion of panelists who evaluated the nuggets: (a) blindfolded (n = 50); (b) non-blindfolded (n = 52) consumers. Formulations: C: control nugget; S10: nugget with 10% red pomace seasoning added to the breadcrumb; S25: nugget with 25% red pomace seasoning added to the breadcrumb.
The cut-off point was 20% of consumers stating that an attribute was "much less" (−) or "much more" (+). * indicates significant differences ($p < 0.05$) between the Overall Liking (OL) means of the categories "much less", "much more", and "JAR". (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

The penalty analyses of the scores of the non-blindfolded consumers (Fig. 3b) resulted in penalties exceeding 1, but with a response percentage lower than 20% for the 3 types of formulations, indicating that none of the above parameters significantly influenced the overall acceptability of the chicken nuggets. Similar results were found by Ortega-Heras et al. (2019) when red pomace seasoning was added to the recipe for whole-wheat muffins.

Penalties for the color of the nuggets were calculated; however, it

should be noted that the response percentage in the "JAR" category was lower than 20%. According to Popper (2014), attribute skews with less than 20% of responses are likely to be inconsequential for PA purposes. In this context, the high response percentage in the category "much more" (92% to S10 and 98% to S25) highlighted that color was one of the parameters furthest from the "ideal color", although the correlation with the OL of the nuggets could not be considered. Therefore, the acceptability of the nuggets was not primarily color dependent; and other attributes could equally influence acceptance. Such results are in partial agreement with those of Cardona, Izquierdo, Barat, and Fernández-Segovia (2023) who after an exhaustive review concluded that the most relevant intrinsic attributes influencing acceptance in meat and meat products were taste/flavor, texture, appearance, color, and odor.

A comparison of the PA results (Fig. 3) for the values of the (blindfolded and non-blindfolded) consumers indicated that, among the non-blindfolded consumers (Fig. 3b), overall acceptance depended on the combined perception of all attributes (surface color, juiciness, crispness, oiliness, saltiness, chicken flavor). In contrast, the blindfolded consumers (Fig. 3a) appeared to focus more on evaluating each attribute individually, mainly in those attributes that in the case of the S25 nugget had a significant influence on acceptability (juiciness, chicken flavor, and crispiness). Damaziak et al. (2019) demonstrated that the lack of sight is compensated by other senses, the intensified perception of which enables a more precise sensory evaluation of food in terms of such parameters as aroma, tenderness and juiciness in poultry meat.

According to the results and in view of the PA, the nugget elaborated with 10% seasoning added to the breadcrumb would likely succeed in the market after its reformulation. The reformulation could involve, on one hand, changing the type of breadcrumbs to a cereal-enriched coating, for example, that could enhance the perception of the product's crispiness. On the other hand, part of the water of the formula, could be replaced with chicken broth to increase the intensity of the chicken flavor.

3.2.4. *Purchase intention*

Consumer responses were favorable towards the control nuggets with similar and high percentages of purchase intention among the blindfolded (84%) and the non-blindfolded (85%) consumers. Moreover, the higher the concentration of red pomace seasoning in the nugget breading, the lower the percentage of purchase intention (non-blindfolded: 60% for S10, and 40% for S25; blindfolded: 70% for S10, and 46% for S25), but it should be highlighted that the intention to purchase seasoned nuggets was lower among the non-blindfolded consumers. Those results appeared to indicate that color was a factor determining consumer purchase intention. Although appearance can affect acceptance and sensory perception, as previously discussed in this study, it should be considered, that most of the time, consumers will often decide to buy a new product without having tried it first. Therefore, using non-blindfolded participants is practical and necessary, because real consumers will always see the product at the point of sale, and appearance and color will be key factors for determining the purchase intention, when they have not smelt or tasted the product before.

One solution to counteract the negative effect of color on any intention to purchase the nuggets could be to inform the consumer of its origin, emphasizing the positive effect that the presence of bioactive compounds from grape pomace can have on health (Gerardi, Cavia-Saiz, & Muñiz, 2022). Gutierrez-Gonzalez et al. (2023) studied white wine pomace as seasoning for chicken breast and reported that the contact of the seasoning with the meat can be deemed safe and that it could be used as a functional ingredient, due to the beneficial effect of the colonic fermentation fraction on the microbiota and its capability to modulate cell oxidative stress. Furthermore, in view of the currently booming "environmentally-friendly" category (Miranda-De La Lama et al., 2017), advertising the seasoning and its contribution to environmental sustainability and the circular economy (through the reuse of winemaking by-products) could help increase purchase intention. However, it should be taken into account how consumers interpret the information that is provided. In this context, Beriain et al. (2020) investigated the sensory acceptability and Willingness To Pay (WTP) for a beef patty enriched with *n*-3 fatty acids and vitamin D_3 under different consumer information scenarios, concluding that the perception of the new patty improved and WTP only increased when the nutritional information was meaningful and understandable for consumers. Therefore, the information provided to consumers on the aforementioned positive effects of the seasoning should be relevant and understandable and further research will be necessary to assess consumer responses and their effects.

4. Conclusion

The acceptability of chicken nuggets was not penalized by significant changes to color. Furthermore, seeing or not seeing the nuggets also affected the sensory perception of other attributes such as texture and flavor, so it could be asserted that the acceptability of the nuggets depended on proper integration of all sensory properties. Furthermore, according to the PA, the "new" nuggets, incorporating moderate levels of seasoning in the breadcrumb, could succeed in the market after a reformulation to enhance the chicken flavor of the nugget. Although this study has certain limitations, such as the number of (blindfolded and non-blindfolded) panelists, it could serve as a basis for future studies where the number of consumers is increased in both the blindfolded and non-blindfolded groups and other traditional products with drastically altered color are evaluated, to determine whether the results obtained in the present study can be extrapolated to other types of food.

However, unexpected color negatively affected purchase intention, so other factors, rather than acceptability, influenced the purchase decision. Thus, it would be necessary to implement appropriate marketing strategies that eliminate purchasing barriers. One of them could be based on helping consumers to understand the benefits of the ingredients responsible for the color changes, such as the seasoning, which in this case is a natural food preservative that is environmentally friendly and has health benefits due to its bioactive compounds. Nonetheless, further research will still be necessary to assess whether providing consumers with information about the positive effects of seasoning, both on human health and the environment, could help their response. Finally, it should be highlighted that the lack of sight enhances the perception of other sensory attributes, probably because, under this condition, consumers can be more intensely focused on the evaluation of non-visual sensory parameters.

The development of innovations to improve a traditional product can lead to drastic change in its appearance, so using blindfolded consumers can be a useful way of evaluating the sensory characteristics of the product without being influenced by its appearance, thereby improving its acceptability. In addition, the practical purpose of this study using blindfolded consumers was to assess whether the sensory characteristics of the product were influenced by its appearance. Thus, knowledge of the perceived sensory attributes of a product and the appearance-related effect on final product acceptance could help us to focus marketing strategies for new innovative meat products on other aspects of the product, especially health benefits.

CRediT authorship contribution statement

Inmaculada Gómez: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Miriam Ortega-Heras:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Data curation, Conceptualization. **Ma Luisa González-SanJosé:** Writing – review & editing, Writing – original draft, Resources, Methodology, Investigation, Funding acquisition, Conceptualization.

Ethical statement

All the panelists were informed about the products, the aim of the project, and the assay. Their participation was voluntary, and they were free to leave the test without having to give a reason. According to General Data Protection Regulation, no answer to any of the questions used in this study included information that can be traced or used to find any person. None of the panelists were remunerated for their participation. This project was approved by the Bioethical Committee of Burgos University (IR27/2023).

Data availability statement

The data presented in this study are available in this article.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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