SUSTAINABLE AND HEALTH CLAIMS *VS* SENSORY PROPERTIES: CONSUMERS' OPINIONS AND CHOICES USING A VEGETABLE DIP AS EXAMPLE PRODUCT

María Mora[a], Elena Romeo-Arroyo[a], Paula Torán-Pereg[a], Carolina Chaya[b], Laura Vázquez-Araújo[a,c,*]

[a]BCC Innovation, Centro Tecnológico en Gastronomía, Basque Culinary Center, Donostia-San Sebastián, España

[b]Department of Agricultural Economics, Statistics and Business Management. Universidad Politécnica de Madrid, Escuela Técnica Superior de Ingeniería Agronómica, Alimentaria y de Biosistemas, Ciudad Universitaria s/n, 28040 Madrid, Spain

[c]Basque Culinary Center, Facultad de Ciencias Gastronómicas, Mondragon Unibersitatea, Donostia-San Sebastián, España

(*) Corresponding author. Email: lvazquez@bculinary.com

KEYWORDS

Sustainable, food waste, consumers, messages, food choice

HIGHLIGHTS

- Potential claims related to sustainability, production, and health were identified
- Different terms for a similar concept elicited different interest
- Sensory properties seemed to drive liking over healthy or sustainable claims

ABSTRACT

New foods development is always challenging and including consumers' opinion during the design process is crucial to increase a successful welcome of the product in the market. During the present study, a whole product design and development process is described, including consumers' insights collected from focus groups, a national online survey, and a final sensory consumer study of the developed vegetable dip. The aim of the study was to determine if some of the extrinsic properties of a product developed using vegetable by-products had an impact on the final product acceptance, or if the intrinsic properties were the main drivers of the acceptance. The experimental design included four focus groups to study consumers' ideas about products made with sustainable ingredients and which may have health benefits. Then, a national survey was conducted to test the best messages associated to the new food. A vegetable dip was developed, using consumers' insights, and a consumer study was conducted to test the impact of three different messages associated with the product. Results of the survey showed three consumers' segments with different interests on the concepts associated with the products, being two of the clusters potential consumers of the new vegetable dip. Results of the consumer study showed that, although consumers belonged to these segments in which the extrinsic properties seemed to be important, the sensory properties drove the acceptance and the 3 tested products were similarly accepted.

1. INTRODUCTION

It has been reported that more than 75 % of new food products fail during the first year after launch (Kemp & Hort, 2015), and using consumers' insights during the product design and development phase could help increasing this success ratio (e.g.: Busse & Siebert, 2018; Talavera & Chambers, 2017). When some of the ingredients used in the new development have specific characteristics (e.g.: high vitamin content), understanding consumers' reactions to these functional or extrinsic properties could be of great interest for the developer; the information relative to the reactions of consumers to the different product-related properties could be used as a powerful communication tool to impact product acceptance (Jaeger, 2006).

According to FAO, food loss and waste have become important problems, meaning over 1.3 billion tons of edible materials per year. Most of the food loss and waste come from fruits, vegetables, roots, and tubers (FAO, 2011). Consumers' explicit interest in sustainability has increased in different countries such as Netherlands, in which 70 % of consumers were either "sustainable consumers" or "concerned with sustainability" (Statista, 2018), or Spain, where a 73 % of population makes consumer decisions for ethical or sustainability reasons (OCU, 2018). Therefore, using food by-products or discarded fruits and vegetables could be of great interest in order to reduce food waste, and also because the consumer niche in sustainable products is increasing. Although this idea is not new, and several studies have been conducted to determine the suitability of different food by-products as ingredients for new foods (e.g.: García, Domínguez, Galvez, Casas, & Selgas, 2002; Lee, Yeom, Ha, & Bae, 2010), investigating the impact of the associated extrinsic properties in these new foods has not been widely investigated yet.

The relationship of consumers' perception of different products with their health-related, organic, local, or production method info, has been explored in different studies. Most of these studies concluded that some specific cues can impact liking on a positive manner, such as "organic", "tradition", or "local/domestic". For example, Januszewska *et al.* (2013) proposed a scale to measure local embeddedness to the region. Results from their study showed three different consumer segments in terms of local involvement. Also, health claims were linked to positive, or not having a significant impact on liking, depending on the product category (Fernqvist & Ekelund, 2014). Although some of these concepts were linked to environmental impact (e.g.: organic, local), consumers' awareness about the impact of food waste has significantly increased in the

last decade, and few studies have been conducted related with the assessment of consumers' perception of foods made with by-products. Henchion, McCarthy, & O'Callaghan (2016), after conducting a qualitative research to determine consumers' attitudes towards meat by-product, suggested to use beef by-products as ingredients for being integrated into existing routines. During the present research, some fruits and vegetable by-products were used as ingredients for developing new products, but consumers' input was used for the whole design and development process. The aims of the research were 1) to collect information related to the opinions and reactions of consumers associated to discarded fruits and vegetable parts, 2) to determine the impact of some of the concepts on the acceptance of the new developed product.

2. MATERIAL AND METHODS

2.1. Consumers' insights for product design

The protocol and procedures used in this study were approved by the Basque Culinary Center scientific committee, which stated a waiver consent. All articles from the Declaration of Helsinki and the 2016/679 EU Regulation on the protection of natural persons regarding the processing of personal data and on the free movement of such data were met. The experimental procedure was explained and a written consent indicating voluntary participation was obtained from each participant prior to beginning the study.

2.1.2. Focus groups

With the aim of i) guaranteeing the greatest acceptance of the product to be designed, and ii) collecting information about consumers' attitudes and reactions to vegetable-waste ingredients, different 1.5 hours focus group (FG) were conducted with 5-8 consumers per group. A total of 24 participants, who actively participate in the groceries purchase of their home, were recruited from the BCCInnovation consumers' database. The FGs were led by a trained moderator, who introduced the discussion talking about the importance of reducing food waste and the nutrients which are yet present in the vegetable by-products. Then, the discussion was directed to determine interests of consumers related to food purchase habits (health benefits of foods, price, sensory properties, etc.). Two interventions were included during the discussion to determine the best way of communicating the properties of the new product to consumers, and also to ask them which products they would like to try and which were made from by-products. The responses were recorded, transcribed, and analyzed. All terms related with the extrinsic characteristics of

105 the product to be developed were organized and collected in a final list of 29 terms (Table 1).
106 Also, five product categories were detected as “interesting for consumers”, which would be later
107 evaluated in the national survey.

108 2.1.2. National survey

109 A next step on the product development phase was to evaluate the different concepts collected
110 during the FG phase, because some of them were quite similar from a technical standpoint but
111 expressed using different terms/lexicon by consumers. To test if some of those terms were more
112 liked than others, and if different segments of consumers could be identified depending on their
113 interests, an on-line national survey was conducted using Compusense® Cloud software
114 (Compusense Inc., Guelh, Ontario, Canada). A total of 495 respondents, who typically participate
115 in the groceries purchase of their homes (32 % men, 68 % women; 33 % from 18 to 35 years old,
116 47 % from 36 to 55 years old, and 20 % older than 56 years old), evaluated their interest in the
117 29 concepts which were collected during the FG phase (Table 1). In addition, consumers’ interest
118 in the 5 different hypothetical new foods, which also came up from the focus groups, was
119 assessed during the survey. A 9-points scale was used in the survey, being 1 = non interested at
120 all, and 9 = very interested. The same scale was used to determine consumers’ interest in the
121 potential 5 new products. Both, concepts and products, were randomly presented for each
122 consumer in the survey.

123 For data analysis, one way-ANOVA was conducted to determine if the concepts elicited different
124 interest in consumers. Post-hoc test was conducted using Tukey’s HSD. Once the concepts were
125 proven to be perceived as significantly different, to determine if some groups of consumers could
126 be identified having different/common interests, a Hierarchical Cluster Analysis, using Euclidean
127 distance and Ward’s criterion of aggregation, was conducted on consumers’ individual data. All
128 statistical analyses were conducted using XLSTAT Version 2009.6.03 (Addinsoft, USA)
129 (Addinsoft, 2019).

130 2.1.3. Product design and consumer test

131 Using the results of the FG and survey phase, a vegetable dip was developed, taking into
132 consideration consumers’ interests. Some of the ingredients of the vegetable dip (pumpkin and
133 orange) were discarded fruits from groceries/catering industry, mainly because of being “ugly”, or
134 in an overripe stage which did not match the quality standards of the companies. Before using

these fruits/vegetables, a drying and milling process had been conducted to obtain fruits/vegetable flours, ensuring a higher shelf life of the product. The main ingredients of the vegetable dip were: beans, dried pumpkin, dried orange pulp and peel, olive oil, lemon juice, and tahini; the recipe was developed by an experienced chef of Basque Culinary Center.

Because the aim of the present research was to determine the importance of the sustainable or health claim/storytelling of the product, the experimental design focused on assessing the impact of 3 different messages on the product acceptance (messages can be read at the results paragraph). A Home Use Test (HUT) consumer study (n = 117; 41 % men and 59 % women; mean age was 30 years old) was conducted, because researchers wanted to ensure that participants consumed the products when they considered more appropriate; HUT has been reported to be more appropriate than Central Location Tests (CLT) whenever the product consumption is expected to be contextual (Boutrolle, Delarue, Arranz, Rogeaux & Köster, 2007). The 3 coded samples, consisting on the same dip, but with 3 different codes and messages, were provided to each consumer (40 g each sample), together with written instructions, and a link to complete the questionnaire using a mobile/tablet. Consumers were asked to complete the test, whenever they considered appropriate to consume the dips, and to follow the instructions of the on-line questionnaire using Compusense® Cloud software (Compusense Inc., Guelh, Ontario, Canada). Consumers were free to choose bread, *crudités,* or no carrier, to taste the different coded samples, but once selected, the use of the same vehicle for the 3 samples was mandatory. Before completing the questionnaire associated which each coded sample, a small paragraph with information about the sample (the concepts/storytelling) was presented to the consumer, and then the corresponding sample was tested and assessed by the respondent. The questionnaire included a 9-points hedonic scale for acceptance (1 = extremely dislike, 5 = neither dislike nor like, 9 = extremely like), and 9-points Just About Right (JAR) questions (1 = too much light, 5 = Just About Right, 9 = too much intense) about color, density, orange flavor, and salty taste. Although the vegetable dip was the same in the 3 samples, the aim of the research was to assess the impact of the 3 different messages on the dip perception, thus the JAR questions were added. Samples presentation was randomized in the on-line survey, guaranteeing that consumers would taste the samples in a different order. Besides asking some demographic questions (e.g.: age),

the questionnaire previously used during the national survey to assess the general interest of consumers in the different concepts collected from the FG, was included.

Consumers were clustered depending on their interests in the different concepts using a Hierarchical Cluster Analysis, using Euclidean distance and Ward's criterion of aggregation. Then, a 2-way ANOVA was conducted using "sample" and "cluster" as factors, and the 2-way interaction "sample*cluster"; post hoc test was conducted using Tukey's HSD. Data analyses were conducted using the statistical package XLSTAT Version 2009.6.03 (Addinsoft, USA).

3. RESULTS

3.1. Focus groups

Different concepts were recorded during the focus groups phase, highlighting the ones shown in Table 1. The conversation included questions related to "health and food", "circular economy and food", and also about the intrinsic and extrinsic properties that attendants considered related with those already discussed subjects. Different terms were used by attendants when talking about circular economy, such as "sustainable", "food waste", "subproducts", etc., eliciting different reactions when talking about them. When driving the conversation to "health and food", most of the comments were related with vitamins, minerals, and other nutrients which may be present in foods, although most of the participants stated not feeling confident with the health claims of processed foods. In general, most participants indicated feeling more confident about food messages when transmitted by a nutritionist/dietician, or when read in technical publications; also, attendants marked "webpages" and "social networks" as the easiest way of obtaining information about food or food ingredients. Different food examples were mentioned by participants when asked about which foods they would like to try knowing that were made using food by-products (e.g.: pumpkin or orange peels); the mentioned foods were grouped in 5 categories: vegetables/fruits/legumes dip, vegetables/fruits flour, mixed fruits and vegetables peels for infusions, dried fruits toppings, and vegetable puff pastry. These 5 food categories, together with the different concepts/ideas collected during the FG (Table 1) were used to design the national survey.

3.2. National survey

Significant differences ($p < 0.05$) were found among interest ratings when studying the concepts assessment (Table 2). In general, some of the concepts elicited higher interest ratings than others

(e.g.: “made with seasonal products” compared with “coming from food waste”). Consumers were clustered in 3 groups which presented different interests profiles: C1 was characterized by a general low interest in all the exposed concepts, C2 included those respondents with a higher discrimination among concepts (high interest for some, and low interest for other concepts), and C3 included those respondents with a general high interest for all the presented concepts, including those closely related with “food waste”, “discards”, or “by-products” (Figure 1).

Results of the evaluation of the interest in the 5 different products showed that the products elicited significantly different interests, highlighting a higher interest in the vegetables dip (mean = 6.62) and a lower interest in the dehydrated fruits/vegetables toppings (mean = 6.26). Therefore, a vegetable dip was developed which included most of the characteristics identified as interesting by consumers, and which could be used to communicate its properties, e.g.: made with natural, seasonal, and local products. Also, some of the ideas were actually considered for the product development: the product was 100% vegetable and no added sugar, neither palm oil, were used as ingredients.

3.3. Product development and testing

Once the product was developed, and the recipe adjusted according to the chef’s criteria, a consumer test (n = 114) was conducted to determine the best communication cues. The developed product was tested, and 3 different messages were used to introduce the samples, aiming to determine if some of the information provided to consumers would impact liking or the perception of some of the product properties. The concepts chosen to be tested in this phase are highlighted in Table 2. Sample coded as “471” was presented with the message: “*this product is made by a local company, with seasonal ingredients, without additives neither added sugars. With the purchase of this product you are contributing to a responsible consumption with the environment*”. This message included some of the concepts that elicited higher interest, especially in consumers’ clusters 2 and 3. Sample coded as “842” was presented with the sentence “*this product is made from the use of peels and discards of fruits and vegetables. It is a km 0 product, and 100 % vegetable*” including some of the concepts linked to the “sustainability” category and which elicited less interest, especially in clusters 1 and 2. Sample coded as “723” was presented with the sentence: “*this product is rich in minerals, has a high fiber content, and favors a slow*

223 *release of energy*", with concepts linked to the "health" category, and significantly less interesting
224 for consumers than those used in sample 471.
225 The same 3 clusters that were identified in the national survey results were also found when
226 analyzing the results of the consumer test (n = 23 for C1; n = 71 in C2; and n = 23 in C3). In
227 general, no significant differences were detected among samples liking (mean = 6.1), but
228 significant differences were detected among clusters ($p < 0.01$): consumers belonging to C3 liked
229 all samples more than consumers who belonged to C1 and C2. JAR data showed that all 3
230 samples were perceived Just About Right regarding color, density, orange flavor, and saltiness
231 (Table 3). Cluster 3 considered the samples significantly denser than clusters C1 and C2, but the
232 messages did not have an impact on the perception of the sensory attributes (Figure 2).

233 **4. DISCUSSION**

234 Results of the present study showed an example of process for product development in which
235 consumers are included during the different steps of the product development. Including
236 discarded fruits/vegetables or fruits/vegetables by-products as ingredients for different foods
237 could be an interesting way of fighting food waste, and consumers showed general positive
238 attitudes to this idea during the focus groups phase. In general, demand in the "snack food"
239 segment is increasing; the income of this market (not including dried fruits neither meat snacks)
240 currently represents approximately 4% of the global food market, and is forecasted to grow to
241 almost US$193 billion worldwide at retail selling prices by 2023 (Statista, 2019). This segment
242 includes a wide variety of salty and savory foods such as potato chips, nuts, dried fruits, and even
243 some meat products. Some of the products mentioned during the focus groups phase, which were
244 mentioned as interesting by attendants, and could include vegetable by-products as ingredients,
245 belonged to this snack category (e.g.: vegetable dip). In addition to the aforementioned interest
246 for consumers in sustainability (Statista, 2018; OCU, 2018), the study highlights the potential
247 increase in the healthy snacks market in the next years. It has been reported a great interest in
248 dried fruits snacks, maybe due to their high content in minerals, vitamins, phytonutrients, and
249 fiber. Increasing awareness regarding their health benefits among consumers in some European
250 countries (e.g.: U.K., Germany, France), may encourage the demand for these products during
251 the next years (Grand View Research, 2019). In addition, results of the present study showed that

using fruits and vegetable by-products as ingredients for designing new and healthy snacks was well-accepted by respondents of the focus groups.

Consumers segments identified using the national survey provided useful info about the importance of using some concepts when talking about the extrinsic properties of some foods. For example, it is to note the differences among the concepts “local product”, “closeness”, and “km 0”, the three of them significantly different, although all of them referring to the geographical origin of the product. In general, all the terms related with using by-products (e.g.: “made using food by-products” or “made with ugly fruits”) were significantly less liked than general terms which could include this concept such as “responsible with the environment”, “contributing to a responsible consumption” or “integral use of the fruit / vegetable”. It has been reported that food choice patterns are influenced by ethics reasons, including somehow “origin” and “environmental” factors, and those are somehow included in the Food Choice Questionnaire developed by Steptoe, Pollard, & Wardle (1995). Later, different concepts associated with sustainability were added in a wider food choice questionnaire developed by Sautron, Péneau, Camilleri, Muller, Ruffieux, Hercberg, & Méjean (2015), some of them related with food waste, and some with pollution or packaging. It is important to indicate that these researchers identified that the concern about “proximity” seemed to be related with preserving national economy more than protecting the environment; this trend had also been reported by other authors (e.g.: Chambers, Lobb, Butler, Harvey, & Traill, 2007). A study conducted by Januzewska *et al*. (2013), conducted in 15 countries, showed the impact of regional embeddedness in consumer segmentation; the specific segment “strong local supporters” was related with holding a strong emotional bond with their region, and a tend on purchasing local food products.

Results of the survey conducted in the present study indicated that not just different concepts related with sustainability or production elicited different interest among consumers, but also that the interest on the sentence/term used to describe the same idea was rated significantly different. A deeper study to determine the different understanding of the various terms would clarify if consumers are associating some of the terms to different categories such as reported by Sautron *et al.* (2015). Also, future cross-cultural studies could expose the different perception to similar sustainability associated terms, providing cues about the best way of promoting new environmentally friendly foods.

Although the national survey results indicated that some of the information linked to the samples could have an impact on samples liking, results of the consumer test conducted in the present study showed the opposite. Different authors have reported data to show how diverse information related to food products has a clear influence on products liking (Piqueras-Fiszman & Spence, 2015). For example, dietary fiber information was proven to have an impact in the perception of different sensory properties of breads and English muffins, as well as acceptance, in Chinese Malaysian and Australian consumers (Mialon, Clark, Leppard, & Cox, 2002). Also, Ekelund, Fernqvist, & Tjärnemo (2007) reported that tomatoes labelled as “organic” or “local” received higher liking scores than the same tomato labelled as coming from a different country. These are some examples of foods which liking or sensory perception was modified due to labels related with health claims, sustainability, or even the name of the food product (e.g.: Miller & Kahn, 2005). During the present study, all samples were similarly liked, despite having different labels with diverse information regarding production (e.g.: “made with seasonal products” *vs* “km 0”) or health related claims (“no added sugar” *vs* “with a high fiber content”). Independently of the information provided to consumers, and even using the claims which were less liked by all clusters (e.g.: “coming from discards”, used in sample 842), acceptance of the 3 studied samples was similar. These results agreed with the results reported by other authors whose studies indicated that sensory properties were the drivers of food choice or liking, or maybe more important that other extrinsic properties (Vázquez-Araújo, Chambers, & Cherdchu, 2012; Brečić, Mesić & Cerjak 2017; Oliveira, Ares, & Deliza, 2017). In addition, these results could be associated with the category of the product; because snacks are generally understood as “comfort foods” in Spain, consumers might have focus on the hedonic component of the product (sensory properties) instead of its extrinsic properties (messages associated to each sample). Drivers of liking have been demonstrated to be product category dependent (Li, Jervis, & Drake, 2015), and this could be the case of snack foods in the Spanish market.

Although results should be considered tentative because of the different n of each cluster, significant differences were found among clusters. Consumers included in Cluster 3 (C3) liked all samples more than consumers who belonged to clusters 2 and 1. In addition, consumers of cluster 3 perceived all samples as being “denser” than consumers of clusters 2 and 1 (Table3). C3 was characterized by higher interest scores in all the terms assessed in the survey, including

312 those related with “food waste”, “discards” and “by-products” which were significantly less
313 interesting for C1 and C2. Several studies have demonstrated that the perception of products can
314 vary depending on consumers’ sensitivity to the extrinsic properties of the product. For example,
315 Laureati, Jabes, Russo, & Pagliarini (2013) found that individuals interested in sustainability
316 issues rated expectations and liking of products labeled as “organic” in a different manner than
317 those who were not interested in sustainability topics. In the present research, consumers
318 belonging to C3 liked all samples more, maybe because a vegetable dip-snack was a product
319 which fitted better within this cluster’s interests. Further studies should be developed to determine
320 the interests of the different consumer niches for healthy and sustainable snacks in Spain, and
321 also to understand the differences with other countries, promoting the inclusion of local vegetable
322 by-products as well-accepted ingredients.

323 **5. CONCLUSIONS**

324 A series of focus groups conducted with Spanish consumers allowed identifying a positive
325 reaction to consumers towards using fruits and vegetables by-products as ingredients for different
326 food categories. In addition, different terms related with sustainability, production, and health
327 claims were identified as associated with these by-products. Three different consumer clusters
328 were identified, showing different interests to the concepts identified during the focus groups. In
329 addition, some of the concepts were significantly more liked than others, highlighting in these
330 results the importance of using the appropriate terms when communication with consumers.
331 Although a national survey indicated that general terms such as “integral use of the
332 fruit/vegetable” or “responsible with the environment” would enhance liking of a new development
333 if compared with specific terms such as “Km 0” or “rich in minerals”, results of a home-use-test
334 showed the opposite. Liking of a vegetable dip developed with vegetables and fruits by-products
335 liked the same independently of the messages associated to the sample. Further studies are
336 necessary to better understand consumers’ reactions to similar ideas expressed using different
337 terms (e.g.: “local” *vs* “Km 0”) and also to understand the healthy and sustainable snacks market
338 niche interests (sensory and rewarding *vs* health *vs* sustainability).

339 **6. ACKNOWLEDGEMENTS**

The authors want to acknowledge the Basque Government for funding NUTRACEUTICAL OMNIUM project (ZL-2019/00351), in which the present research is included, and also the participants in the consumer studies for their helpful collaboration.

7. REFERENCES

Addinsoft. (2019). XLSTAT statistical and data analysis solution. Long Island, NY, USA. Retrieved from https://www.xlstat.com.

Boutrolle, I., Delarue, J., Arranz, D., Rogeaux M., & Köster E.P. (2007). Central location test vs. home use test: Contrasting results depending on product type. *Food Quality and Preference, 18*, 490–499. doi:10.1016/j.foodqual.2006.06.003

Brečić, R., Mesić, Ž., & Cerjak, M. (2017). Importance of intrinsic and extrinsic quality food characteristics by different consumer segments. *British Food Journal, 119*(4), 845–862. doi:10.1108/bfj-06-2016-0284

Busse, M., & Siebert, r. (2018). The role of consumers in food innovation processes. *European Journal of Innovation Management. doi: 10.1108/EJIM-03-2017-0023*

Chambers, S., Lobb, A., Butler, L., Harvey, K., & Traill, W. B. (2007). Local, national and imported foods. A qualitative study. *Appetite, 49*(1), 208–213. https://doi.org/10.1016/j.appet.2007.02.003

Ekelund, L., Fernqvist, F., & Tjärnemo, H. (2007). Consumer preferences for domestic and organically labelled vegetables in Sweden. *Acta Agriculturae Scandinavica- Section C Food Economics, 4*, 229-236. https://doi.org/10.1080/16507540701800665

FAO. (2011). Food loss and food waste. Retrieved in February 2020 from http://www.fao.org/food-loss-and-food-waste/en/.

Fernqvist, F., & Ekelund, L. (2014). Credence and the effect on consumer liking of food – a review. *Food Quality and Preference, 32*, 340-353. https://doi.org/10.1016/j.foodqual.2013.10.005

García, M.L., Domínguez, R., Galvez, M., Casas, C., & Selgas, M.D. (2002). Utilisation of cereal and fruit fibres in low fat dry fermented sausage. *Meat Science, 60*, 227-236. DOI: 10.1016/s0309-1740(01)00125-5

Grand View Research. (2019). Healthy snacks market size, share & trends analysis report by product (dried fruit, cereal & granola bars, nuts & seeds, meat, trail mix), by region, vendor landscape, and segment forecasts, 2019 – 2025. Report ID: GVR-1-68038-915-9.

Retrieved from: https://www.grandviewresearch.com/industry-analysis/healthy-snack-market

Henchion, M., McCarthry, M., & O'Callaghan, J. (2016). Transforming beef by-products into valuable ingredietns: which spell/recipe to use? *Frontiers in Nutrition, 3*, 53. doi: 10.3389/fnut.2016.00053

Jaeger, S., (2006). Non-sensory factors in sensoy science research. *Food Quality and Preference, 17*(1-2), 132-144. DOI: 10.1016/j.foodqual.2005.03.004

Januszewska, R., Mettepenningen, E., Majchrzak, D., Williams, H. G., Mazur, J., Reichl, P., Regourd, A., Jukna, V., Tagarino, D., Konopacka, D., Kaczmarek, U., Jaworska, D., Wojtal, S., Sabau, M., Cofari, A., Tomic, N., Kinnear, M., De Kock, H.L., Chaya, C., Fernández-Ruiz, V., Brugger, C., Peyer, L., Aldredge, T.L, & Valenzuela-Estrada, M. (2013). Regional embeddedness segments across fifteen countries. *Journal of culinary science & technology*, *11*(4), 322-335. https://doi.org/10.1080/15428052.2013.798603

Kemp, S., & Hort, J. (2015), "Trends in sensory science", in Food Science and Technology, Vol. 29 No. 1, pp. 36-39.

Laureati, M., Jabes, D., Russo, V., & Pagliarini, E. (2013). Sustainability and organic production: How information influences consumer's expectation and preference for yogurt. Food Quality and Preference, 30, 1-8. https://doi.org/10.1016/j.foodqual.2013.04.002

Lee, E-H., Yeom, H-J., Ha, M-S., & Bae, D-H. (2010) Development of banana peel jelly anmd its antioxidant and textural properties. *Food Science and Biotechnology, 19*(2), 449-455. DOI 10.1007/s10068-010-0063-5

Li, X.E., Jervis, S.M., & Drake, M.A. (2015). Examining extrinsic factors that influence product acceptance: A review. *Journal of food Science, 80*(5), 901-909. doi: 10.1111/1750-3841.12852

Mialon, V. S., Clark, M. R., Leppard, P. I., & Cox, D. N. (2002). The effect of dietary fibre information on consumer responses to breads and "English" muffins: a cross-cultural study. *Food Quality and Preference, 13*(1), 1–12. https://doi.org/https://doi.org/10.1016/S0950-3293(01)00051-9

Miller, E. G., & Kahn, B. E. (2005). Shades of meaning: The effect of color and flavor names on consumer choice. *Journal of Consumer Research, 32*, 86-92. DOI: 10.1086/429602

OCU. (2018). Otro consumo para un futuro mejor. Nuevas economías al servicio de las personas y el planeta. Retrieved from C:/Users/lvazquez/Desktop/Otroconsumoparaunfuturomejor-Informe.pdf

Oliveira, D., Ares, G., & Deliza, R. (2017). Influence of intrinsic and extrinsic factors on consumer liking and wellbeing perception of two regular and probiotic milk products. *Journal of Sensory Studies, 32*(3), e12261. https://doi.org/10.1111/joss.12261

Piqueras-Fiszman, B., & Spence, C. (2015). Sensory expectations based on product-extrinsic food cues: An interdisciplinary review of the empirical evidence and theoretical accounts. *Food Quality and Preference, 40*, 165-179. https://doi.org/10.1016/j.foodqual.2014.09.013

Sautron, V., Péneau, S., Camilleri G.M., Muller, L., Ruffieux, B., Hercberg, S., & Méjean, C. (2015). Validity of a questionnaire measuring motives for choosing foods including sustainable concerns. *Appetite, 87*, 90-97. http://dx.doi.org/10.1016/j.appet.2014.12.205

Talavera, M., & Chambers, E., IV. (2017). Using sensory sciences help products succeed. *British Food Journal, 119*(10), 2130-2144. https://doi.org/10.1108/BFJ-10-2016-0486

Statista. (2018). Distribution of consumers in the Netherlands in 2018, by interest in sustainability. Retrieved from https://www.statista.com/statistics/922567/consumer-interest-in-sustainability-in-the-netherlands/

Statista. (2019). Food Report 2019 - Snack Food. Retrieved from: https://www.statista.com/outlook/40110000/100/snack-food/worldwide#market-volume

Steptoe, A., Pollard, T. M., & Wardle, J. (1995). Development of a measure of the motives underlying the selection of food: the food choice questionnaire. *Appetite, 25*(3), 267–284. https://doi.org/https://doi.org/10.1006/appe.1995.0061

Vázquez-Araújo, L., Chambers, E. IV., & Cherdchu, P. (2012). Consumer input for developing human food products made with sorghum grain. *Journal of Food Science, 77*(10), 384-389. doi: 10.1111/j.1750-3841.2012.02917.x

426 Table 1. Concepts collected during the FG phase, mentioned when discussing about the food
427 purchase interests of consumers, and later on evaluated in an on-line national survey.
428 Legend. Concepts have been coded as shown in the figures to facilitate reading.
429

Concept assessed by consumers in the national survey	
Q1. Coming from discards	Q16. 100% Vegetable
Q2. Made with ugly fruits	Q17. Made with seasonal products
Q3. Made from fruit and vegetable peels	Q18. Without palm oil
Q4. Made with food waste	Q19. Integral use of the fruit / vegetable
Q5. Made using food by-products	Q20. Traditional recipe
Q6. Sustainable	Q21. No added sugar
Q7. Responsible with the environment	Q22. With a high fiber content
Q8. From the reuse of ...	Q23. Real food
Q9. Closeness	Q24. With a short list of ingredients
Q10. Local product	Q25. Without additives
Q11. Km 0	Q26. Rich in vitamins
Q12. With natural ingredients	Q27. Rich in minerals
Q13. Natural / sustainable packaging	Q28. Slow release of energy
Q14. Ecological	Q29. With a QR (information on:
Q15. Contributing to a responsible consumption	traceability, raw materials, production system, etc.)

430
431

Table 2. One-way ANOVA results of the national survey (n = 495). Post-hoc test was conducted using Tukey's HSD. Bold indicating the concepts tested in sample 471 (expected to be more liked) and italic for those tested in sample 723 and 842 (expected to be less liked).

Concept		INTEREST SCORE	Tested in sample:
Q17	Made with **seasonal** products	7.854 a	471
Q7	**Responsible with the environment**	7.836 a	471
Q10	**Local** product	7.836 a	471
Q12	With natural ingredients	7.662 ab	-
Q25	**Without additives**	7.594 abc	471
Q21	**No added sugar**	7.563 abc	471
Q18	Without palm oil	7.507 abcd	-
Q15	Contributing to a responsible consumption	7.474 abcd	-
Q6	Sustainable	7.468 abcd	-
Q13	Natural / sustainable packaging	7.412 abcd	-
Q19	Integral use of the fruit / vegetable	7.343 bcd	-
Q9	Closeness	7.327 bcd	-
Q24	With a short list of ingredients	7.238 bcde	-
Q26	Rich in vitamins	7.206 cde	-
Q14	Ecological	7.082 def	-
Q22	*With a high fiber content*	6.866 efg	723
Q20	Traditional recipe	6.757 fgh	-
Q29	With a QR (information on e.g. traceability)	6.672 fgh	-
Q16	*100% Vegetable*	6.670 fgh	842
Q27	*Rich in minerals*	6.507 ghi	723
Q11	*Km 0*	6.388 hij	842
Q23	Real food	6.216 ij	-
Q8	*From the reuse of ...*	6.026 jk	842
Q3	*Made from fruit and vegetable peels*	5.670 kl	842
Q28	*Slow release of energy*	5.652 kl	723
Q2	Made with ugly fruits	5.280 lm	-
Q5	Made using food by-products	5.108 m	-
Q1	Coming from discards	5.107 m	842
Q4	Made with food waste	4.891 m	-
Pr > F(CONCEPT)		< 0.0001	

436 Table 3. Two-way ANOVA and Tukey HSD results of Liking and JAR data.

	ANOVA			Cluster			Sample		
	Sample	Cluster	Sample* Cluster	3	2	1	471	723	842
Liking	0.790	**< 0.0001**	0.527	6,66 a	5,65 b	5,93 b	6,02 a	6,16 a	6,07 a
Density	0.749	**0.001**	0.954	5,88 a	5,43 b	5,42 b	5,51 a	5,63 a	5,60 a
Orange flavor	0.824	0.641	0.966	4,99 a	4,91 a	4,74 a	4,98 a	4,80 a	4,86 a
Color	0.602	0.125	0.730	5,26 a	5,22 a	4,97 a	5,20 a	5,06 a	5,18 a
Saltiness	0.743	0.095	0.994	4,57 a	4,22 a	4,42 a	4,48 a	4,39 a	4,34 a

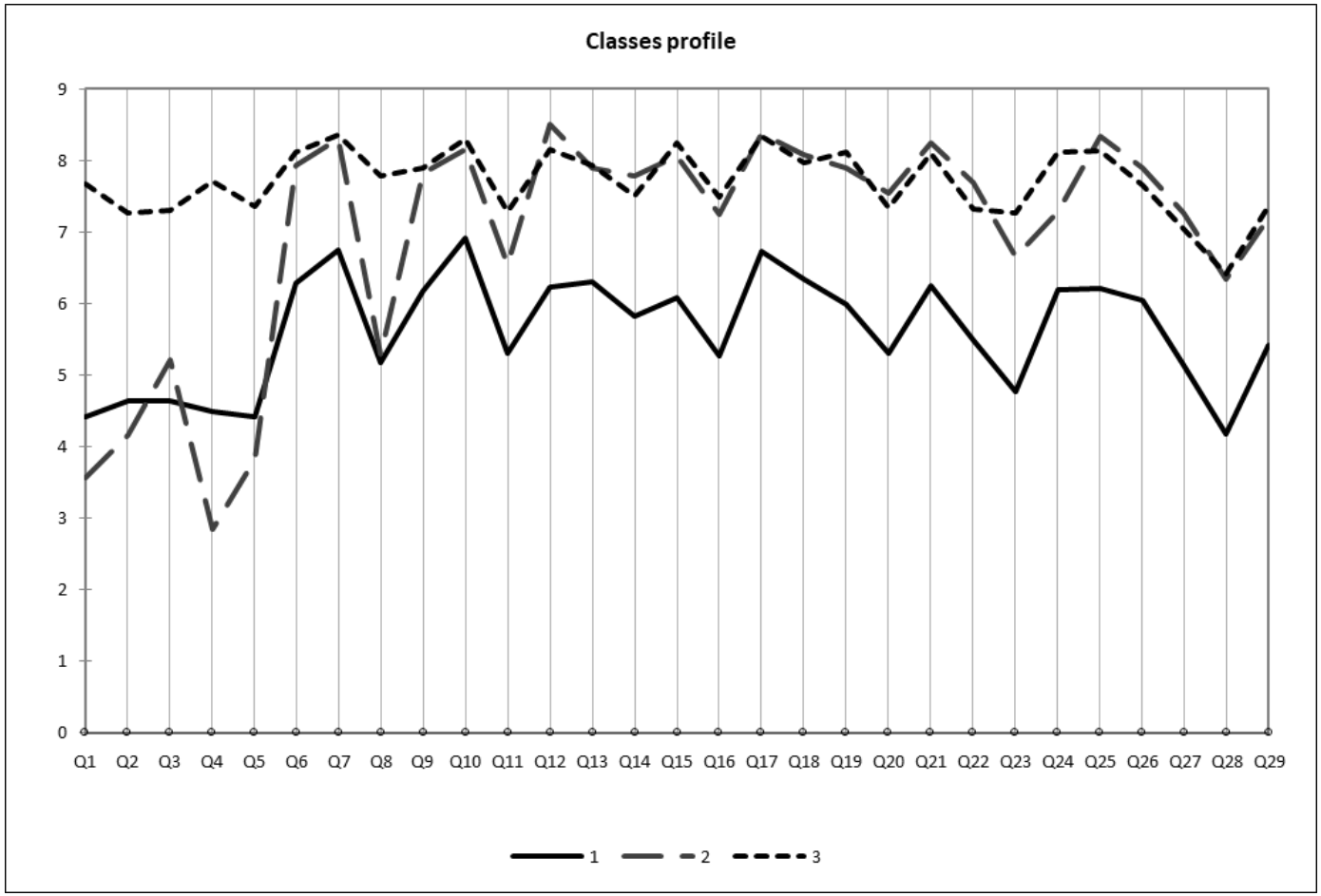
437

438 Figure 1. Hierarchical Cluster Analysis using Euclidean distance and Ward's criterion of aggregation. with the National Survey responses.

439 Legend: Q1, Q2, etc. are the assessed concepts, coded as indicated in Table1. "1", "2", and "3" are the 3 identified clusters (n = 188, 174, and 133 for C1, C2

440 and C3 respectively).

441



442 Figure 2. Liking of samples in the 3 clusters.

443 Legend. Results of 2-way ANOVA showed significant differences ($p < 0.05$) among clusters, but no significant differences were detected among samples.

444