Consumer´s categorization of food ingredients: Do consumers perceive them as 'clean label' producers expect? An exploration with projective mapping

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Abstract

Consumers are said to increasingly assess processed food in terms of whether or not they perceive it to be 'clean label' food. This term refers to what is seen as little processed and 'natural' or 'free from' negatively associated ingredients, or even organic food. However, it is difficult for food producers to predict how their product ingredients will be perceived, and how they should position new products. The present study aimed at exploring how consumers perceive and categorize food ingredients, and testing this under different communication frames. These frames are positioning the product in relation to different consumer choice motives. Potato protein as a replacement for negatively associated ingredients was used a case study. Ninety consumers participated in a projective mapping task in Denmark that consisted of placing and characterising ingredients on a bi-dimensional surface. In a between-subjects design, three groups of consumers had to map the ingredients of four products (dairy-free ice cream, vegetarian candy, plant-based sausage, and a protein drink). In each group products were presented as either sustainable, healthy, or plant-based. The results showed that consumers categorized ingredients in terms of firstly and secondly, objective type of ingredient or its function, and thirdly, subjective individual assessment of its value. Communicational framing had little impact, but ingredient-level differences emerged from the comparison of the frames. Despite product-related differences, a similar pattern emerged for the different food categories. Findings confirm that consumers perceive ingredients according to a 'known-natural-good' vs. the opposite category. Implications for food industry are discussed.

Keywords

Projective mapping, potato protein, clean label, consumer perception, framing

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1. Introduction

Consumers are increasingly interested in both health and sustainability aspects of their way of living in general (Euromonitor International, 2017; Aschemann-Witzel, 2015; Verain, Sijtsema, & Antonides, 2016) and their diet in specific. They demand foods which are more natural (Hemmerling, Asioli, & Spiller, 2016; Román, Sánchez-Siles, & Siegrist, 2017) and organic (Janssen, 2018), are less processed and 'free from' ingredients which are perceived negatively in various ways, such as, for example, allergen-related ingredients or additives (Ingredion, 2014). Conceptually, these are different trends on the food market, driven by different motives, as, for instance, health, sustainability, or risk avoidance (Grunert, 2013), but it is expressed in the phenomenon of a trend to consume more plant-based food products. Food producers are increasingly striving to meet these trends by offering 'clean label' foods (Ingredion, 2014). Such clean label foods are based on the assumption that consumers classify ingredients according to whether they appear natural and known, or processed and un-natural, and that they favourably perceive the first and avoid the latter.

Many clean label products are reformulated products with rephrased ingredient descriptions, or new product developments. With many relaunched or new food products failing on the market (Stewart-Knox & Mitchell, 2003), it is particularly important to address potential consumer concerns early on (van Kleef, van Trijp, & Luning, 2005). This can be achieved by studying consumer behaviour using diverse and combined methods (Asioli et al., 2017), or involving consumers in consumer-led new product involvement (Costa & Jongen, 2006) and co-creation (Banović, Krystallis, Guerrero, & Reinders, 2016).

To identify success factors of the clean label trend, it is important to understand consumers' perception of individual ingredients in the context that they are presented in. That is, to have an in-depth understanding of firstly, how consumers categorize ingredients as such or in the context of the product category in question, and secondly, and to have an understanding of which is the best positioning of the food product in relation to one of the market trends and consumer benefits communicated. However, there is limited research on consumer

categorisation of food ingredients, even though food producers have assumptions about how consumers go about interpreting the ingredient lists. In particular, little is known about how categorisation of clean label food ingredients might be affected by the benefit communication of the product concept. Given the diversity of ingredients, food categories, trends and motives, a more in-depth understanding of consumers' categorisation behaviour and ingredient perception is needed to prepare the market entry of new ingredients or the launch of new clean label foods.

On this backdrop, the aim of the current research was to explore the following research questions, using plant-based products with potato protein as a new substitute ingredient as a case and a projective mapping approach:

1. How do consumers perceive and categorize ingredients of products from the 'clean label' trend?
    a. Which ingredients are categorized together or apart, indicating perceived similarity or difference?
    b. Which descriptors are applied to ingredient groups, indicating underlying distinctions that consumers use and the perception of the ingredient?
    c. Are descriptors positively or negatively perceived?
2. Which differences in categorisation and perception are observed when the product is presented with different communicational framing as either a) more sustainable, b) healthier, or c) with a focus on the specific plant source?

1.1 Clean label consumer trend

There is no commonly accepted definition of a 'clean label' product (Asioli et al., 2017), but clean label products are typically understood as products which consumers prefer due to the absence of negatively perceived ingredients in the ingredient list. These can be allergenic ingredients, additives, industrially processed ingredients, or those perceived as unfamiliar and chemical-sounding. Instead, clean label products are characterised by the presence of ingredients perceived as natural, harmless and simple and which consumers know and use themselves ('kitchen cupboard ingredients') (Busken, 2013; Ingredion, 2014; Varela & Fiszman, 2013). In its strict sense, 'clean label' products can be understood as foods exhibiting an ingredient list which is characterised by being "short, simple, no artificial ingredients, not 'chemical-sounding', with 'kitchen cupboard ingredients' that are expected

and familiar" (Asioli et al., 2017, p. 61). Some market research companies use a broader definition and position organic, natural and 'free from' jointly under the umbrella term of 'clean label' (Ingredion 2014).

The basic driver of the trend is consumers' increasing desire to avoid certain ingredients and seek 'naturalness' (Euromonitor International, 2016). This trend also triggers consumers to turn to products such as certified organic food (Janssen, 2018) and food positioned as natural (Burdock & Wang, 2017). In fact, it has been found that organic food choice appears to be driven by modern health concerns (Devcich, Pedersen, & Petrie, 2007), negative associations with chemicals (Dickson-Spillmann, Siegrist, & Keller, 2011) as well as scepticism about functional food developments (Aschemann-Witzel, Maroscheck, & Hamm, 2013) and unknown ingredients (Evans, Challemaison, & Cox, 2010). Naturalness in food is sought because of associations of more traditional and 'authentic' processing, leading to assumptions about favourable health effects (Amos, Pentina, Hawkins, & Davis, 2014). Consequently, food producers respond by altering their ingredient lists in order to move closer to the idea of 'clean label' foods.

1.2 Communicational framing

Consumer interest in understanding ingredients and preferring certain ingredients over others may have a number of underlying drivers. These may include healthy eating motivations, concern for the environment or sustainability impact of supply chain practices, preference for local food, or avoidance of risks (Sautron et al., 2015). Food choice motives are related to the various dimensions of food quality (Grunert, 2005; Oude Ophuis & van Trijp, 1995). Which one of the aspects is most salient when a consumer inspects a product's ingredient list thus also depends on the accompanying information: While perceiving the product and arriving at an assessment, both internal and external information is retrieved and used. In line with framing theory (Scheufele, 2004), the context in which information – in this case the ingredient list – is embedded in, is crucially relevant. The context leads to the activation of respectively related previous knowledge or 'schema' in the consumer's mind (Nordfalt, 2010). When the context differs, the assessment and evaluation also differ. In the case of the same ingredient presented on differently positioned food products, this might lead to a different understanding of the ingredient's role in the product, and consequently a potentially different categorisation of the ingredient or association or attitude towards the ingredient. For

example, in accordance with the reasoning of framing theory, naturalness claims on foods have been found to be more favourably received when presented at points of purchase which are in line with 'naturalness', e.g. in a farmer's market (Lunardo & Saintives, 2013). Health claims have been found to be preferred more when embedded in information that underlines the product's naturalness (Aschemann-Witzel & Grunert, 2015). Our study applies framing in terms of different product concepts, communicating the product as either more sustainable, healthier or with a focus on the new substitute ingredient, potato protein.

1.3 Consumer perception and categorisation of ingredients

Given 'clean label' is among other things defined by 'free from', consumer perception of ingredients regarded as 'added' are of particular interest, and this holds for the ingredient category of additives. Moreover, the perception of protein ingredients is of particular interest in this study due to the focus on plant-based products with a new alternative protein.

Additives are defined as substances added to the food for functional-technological or sensory purposes, and they can be of either natural or synthetic origin (Bearth, Cousin, & Siegrist, 2014). Food additives, or any ingredient interpreted and perceived as such, tend to be found as an ingredient consumers strive to avoid (Aoki et al., 2010). Such a consumer focus on avoidance reaction has also been called a 'negativity bias' (Rozin & Royzman, 2001) in consumer behaviour. Expert assessments and consumer perception have been found to differ, given that experts assess the increased food safety due to the use of additives, while consumer attitude is also influenced by their personal values and affective evaluation (Hansen, Holm, Frewer, Robinson, & Sandøe, 2003). Additives can be categorised according to either their application (e.g. preservation, colour, taste) or their origin (natural or synthetic) (Bearth et al., 2014).

An important influencing factor on the perception of ingredients overall and of synthetic food additives in particular is the perception of risk (Bearth et al., 2014), and further, the experience of food scandals related to such additives (Chen, 2017). Consequently, also the trust in processors has shown to be relevant (Szucs et al., 2014). The role of trust is not surprising given that consumers neither have sufficient knowledge about the ingredients nor would they notice whether they are correctly displayed (Cheung et al., 2016). Song and Swartz (2009) found that consumers perceived additives as more harmful when the additives had names that were difficult to pronounce, which means that there is a lack of familiarity:

this creates a greater risk perception. In line with the general tendency of consumers to prefer 'naturalness' (Román et al., 2017), a research review has shown that consumers prefer natural food additives as compared to synthetic additives (Carocho, Morales, & Ferreira, 2015). The avoidance of artificial ingredients can be understood on the background of the fact that consumers are found to be sceptical towards new technologies in food processing overall (Hung, Kok, & Verbeke, 2016). In addition, that consumers seek naturalness and avoid the opposite can also be understood as the application of a simplified heuristic in reading and interpreting ingredient lists or claims (Chalamon & Nabec, 2016). Overall, there is a further need for research on consumer perception of food ingredients in specific food contexts, which is why we use an explorative approach in this study.

1.4 Protein and potato protein as a favourable clean label ingredient

Protein ingredients have been suggested as a potential 'clean label' ingredient (Alting & van de Velde, 2012) and are investigated in relation to consumer trends towards both health and sustainability characteristics of food (Lazzarini, Zimmermann, Visschers, & Siegrist, 2016). However, they may also be interesting because of their associated benefit perception of satiation (Fiszman, Varela, Díaz, Linares, & Garrido, 2014). In line with research on the question of 'adding' something to a food (Rozin & Royzman, 2001), however, it has been found that some consumers might be more sceptical towards foods where protein has been added (Banović et al., 2018).

So far, little research has looked into the perception of various sources of plant-based proteins. It can be assumed that the knowledge about the plant source majorly impacts the perception of the protein as an ingredient. Potato protein can be a valuable alternative protein source given it provides a favourable amino acid combination and a similarly good contribution to nutrition as egg or soy-based protein (Waglay & Karboune, 2016, Ju, Mu, & Sun, 2017). Apart from the nutritional benefit of the protein, selected potato protein fractions, i.e. patatin and protease inhibitors, can have a functional use in a food due to its gelling, foaming or emulsifying properties (Schmidt, Damgaard, Greve-Poulsen, Larsen, & Hammershøj, 2018)[1]. The only potential negative association for potatoes in particular

[1] Chemically, the protein in potato – contained in the 2-5% solids of the potato fruit juice which is a side-stream of potato starch production – consists of protease inhibitor, patatin, and oxidative or starch synthesis enzymes (Schmidt et al., 2018).

known from the literature is the perception of potatoes as high in carbohydrates (Clarke & Best, 2017), which is suggested to explain the decrease in potato consumption (Wood, Carragher, & Davis, 2017). Another potential explanation might be that potatoes may have an image as a traditional, old-fashioned staple food, given they make up the low-cost and satiating share of many traditional dishes in, e.g., north-western European countries, that fed poor industrial workers in the past centuries (Reader, 2011). However, new developments such as the new Nordic kitchen (Bech-Larsen, Mørk, & Kolle, 2016; Micheelsen, Havn, Poulsen, Larsen, & Holm, 2014) could rejuvenate that image. In addition, potatoes do not entail the risk of allergies as linked to beans (Vanga & Raghavan, 2018). Furthermore, they might be favoured by consumers in countries that grow potatoes, because they can be sourced as a local ingredient (Lazzarini, Visschers, & Siegrist, 2017).

1.5 Projective mapping

Research has looked into what consumers associate with certain ingredients using different techniques, as, for example, word association tasks and free listing (Varela, Ares, & Fiszman, 2013; Varela & Fiszman, 2013) or qualitative methods of association (Amos et al., 2014). So far the potential of the projective mapping method for studying ingredient perception is under-explored. Projective methods are essentially defined by triggering consumers to project their internal, unobservable thoughts and network of associations on something external. This can be done via imagining another person's thoughts (thus projecting one's own thoughts on the other being, and answering indirectly) (Catterall & Ibbotson, 2000) or projecting own thoughts onto a surface on a screen or paper following certain instructions (e.g. drawing a map, or a net) (Dehlholm, 2014). The goal is to make these thoughts observable to researchers (Boddy, 2005). Such methods can be used as creative and brainstorm techniques for new product development (Banović, et al., 2016) to describe product perceptions (Vidal, Ares, & Giménez, 2013) or to express a sensory experience (Antúnez, Vidal, Saldamando, Giménez, & Ares, 2017).

Projective mapping (Risvik, McEwan, Colwill, Rogers, & Lyon, 1994) is a method which aims at mapping the perceived similarities and differences between studied objects on a two-dimensional space. Objects closer in the map will share more similarities, while dissimilar ones will be further away. This method allows studying the spatial categorisation of a large number of items (in this case ingredients) as well as analysing the associations that these

ingredients trigger in consumers' minds, as consumers can describe their mapping in a second step (Valentin, Chollet, Lelievre, & Abdi, 2012; Varela & Ares, 2012). In the current study, projective mapping was applied to 'map' consumers' thoughts on how similar or dissimilar ingredients are as well as which associations these ingredients trigger while sorting them. The method thus allows to explore whether the consumers' way of 'seeing' ingredient lists matches with food producers' assumptions, as they are underlying the clean label product formulation. We study consumers' perceptions of ingredients across different product categories of plant-based food products, as these fall into the clean label trend, and explore the impact of different communicational framing.

2. Materials and methods

2.1 Recruitment and sample

The recruitment goal was to only include consumers with an interest in plant-based food products. Thus, recruitment screened for young or middle-aged (up to 50 years of age) consumers in Denmark (having lived at least one year in the country) with an interest in reducing the share of meat in their diet. Inclusion criteria for the latter answering at least 'somewhat agree' to the screening statements of 'I have considered or am considering eating less meat' or 'I have bought at some point / sometimes buy vegetarian products'.

90 consumers in Denmark were invited to participate in a laboratory study about 'consumer perceptions of plant-based food products'. They were quota-sampled to balance the sample in terms of age, gender, and presence of children in the household. Half of the participants were recruited via the university's lab participant pool, and the other half via social media posts or leaflets at local sports clubs, schools and day-care institutions. Depending on the respondents in question, study instructions were given in Danish or English. The respondents were subject to a between-subjects design: 29 respondents participated in the projective mapping task in the experimental condition of 'sustainability framing', 30 participants in the condition of 'health framing', and 31 in the condition of 'plant-based potato protein'. Of the 90 consumers, 53% were students, 47% were of Danish nationality, 63% were female and the mean age was 28.2 years. Due to missing data, the information from eight respondents had to be discarded, resulting in a data set based on 82 respondents. The sample size can be regarded adequate for a projective mapping task (Vidal, Cadena, Antúnez, et al., 2014).

2.2 Stimuli

The stimuli consisted of product concept descriptions varying between-subjects in its communicational framing (see table 1), and the ingredient lists of the four example products (see table 2).

2.2.1 Communicational framing

The product concepts were introduced as text on laminated cards which remained present through the projective mapping task; also, the concepts were introduced orally. The product was introduced in different ways and thus 'framed' through communication in the experimental groups and presented to the consumers as follows (see Table 1 for the description of the product concept):

1) plant-based products being more sustainable (called "sustainable group" later on)
2) plant-based products being healthier ("healthy group"), or
3) plant-based products with potato protein ("potato group").

Insert Table 1

2.2.2 Example products

All product examples were plant-based food products. They were chosen so that potato protein could replace another ingredient to turn the product into a purely plant-based alternative. In addition, the replaced ingredient was considered to be a potential allergen, thereby qualifying the product to follow the clean label trend. Four categories were selected: two hedonic products – ice cream and candy – and two utilitarian products (plant-based sausage and protein drink). One of the products was available in Danish supermarkets, the other products were available in other countries.

Insert Table 2

2.3 Projective mapping task procedure

For each of the projective mappings, the ingredients for each of the four products were provided on small pieces of paper. Respondents were instructed to sort the ingredients in

terms of perceived similarities and differences. Using the whole space provided on a DIN A3 sheet of paper, they were able to group ingredients of similar type (see Table 3 for the instructions). Tape was provided to fix the ingredients to the spot chosen. Respondents were also asked to note down words to describe the groups or ingredients on the sheet of paper, or the reason why they mapped them in that particular way. It was stressed that their own personal view was of relevance, and there were no right or wrong views. A sample projective map – showing the categorisation of objects differing in colour and shape on a sheet – was provided as a help to explain and understand the task.

Insert Table 3

2.4 Analysis

For all respondents in the three experimental groups and all four product categories, the projective maps resulted in DIN A3 paper sheets, which were digitalised. To analyse the similarities and differences, the distance to each ingredient was measured from the lower left corner, and the x and y coordinates were recorded for each ingredient on each individual map. For each experimental group and product category, these distances were entered into an excel worksheet as recommended (Dehlholm, 2014). The ingredient x and y coordinates were measured in centimetres, and frequencies of mention of the attributes were counted across the consumer panel. The resulting table had the products in the rows and the x,y coordinates and attribute frequencies as columns (as many x, y tables as consumers). To analyse the descriptors that respondents wrote down to explain the location and their thoughts about the ingredient or cluster of ingredients they had formed, these descriptors were also entered into an excel file, indicating the ingredient and the related descriptor. The coding process involved all three researchers (two of the authors and a research assistant) who explored the descriptors separately. In coding, text containing various meanings was first coded into various descriptors, and second, descriptors with a synonymous meaning summarized under one joint descriptor. Results were compared to agree on a similar coding approach. To reduce the number of descriptors, the only ones used in the final analysis were those that had been applied by at least 10% of respondents of each experimental group. Projective mapping data was analysed via MFA using the XLStat 2015 software pack (Addinsoft, UK). Coordinates (x,y) of the ingredients on the individual maps were used as active variables, and attributes generated in the descriptive step were over-imposed as supplementary variables and did not

contribute to the construction of the MFA factors (Pages, 2015). Solutions were inspected and when relevant, interpreted until the third dimension. For further details on coding, word processing and data analysis of projective mapping data, see Varela and Ares (2012). MFA was also carried out to compare the ingredient positions on the maps generated in the three framings, providing a superimposed representation of the three framings in the same perceptual space.

Global Chi-square was used for testing the homogeneity of the contingency table of the frequencies of mention of the attributes in the three experimental groups (framings) in the descriptive step of the projective mapping (Symoneaux et al., 2012). When the initial Chi-square was significant, a Chi-square per cell was done within each cell identifying the source of variation of the global Chi-square. The Chi-square per cell analysis was run with an XL macro as in Symoneaux et al. (2012).

3. Results

In section 3.1., the results concerning research questions 1a – 1c are presented by product category in a set of different figures. Due to similarity of results for question 1, the results are presented for all experimental groups jointly. The left panel in each figure displays the consensus map for the ingredient sorting. The right panel displays the descriptors that consumers applied to the respective ingredients. For example, a group of ingredients in the lower left corner in the left panel was described by descriptors in the lower left corner of the right panel. In section 3.2, the results concerning research question 2 are presented across categories, comparing the effect of framing in the different experimental groups.

3.1 Perception and categorisation of ingredients

3.1.1 gelatine-free candy

Consumer categorisation showed a clear distinction into three groups of ingredients, which are set apart from each other in the first two dimensions of the MFA (Figure 1a). The first group (left panel, in the upper left quadrant) contained flavour-related ingredients such as elderberry juice concentrate and citric acid. The second (lower left quadrant) contained ingredients of sugar and syrup, and the third (lower right quadrant) contained the remaining

ingredients ranging from starch, thickener, to gum and protein. From these, when inspecting a third dimension, it can be seen that proteins are perceived as a fourth group (Figure 1b, in the upper right). The descriptors (right panel) show that the flavour-related ingredients were described by terms related to the function of taste and flavour, but also assessed as basic, harmless, and natural. Sugars and syrups were grouped with the function of sweetening in mind, perceived as unhealthy. The third, larger and more heterogeneous group of ingredients is described with descriptors explaining the function – as, for example, consistency, texture or appearance – but also words that express lack of knowledge – unknown, weird – or an association with risks, with processing and with negative thoughts, as, for instance, dangerous, processed, chemical, unnatural, unnecessary. The fourth group containing proteins and emerging in the third dimension is described more positively, however, with words such as healthy, plant, protein, harmless and natural. Thus, the first and fourth groups are positively perceived while the second and third are negatively associated.

Insert Figures 1a and 1b

3.1.2 Dairy-free ice cream

The categorisation of ice cream ingredients again resulted in three clearly distinct and separated groups (left panel, Figure 2). The first (in the upper left quadrant) contains ingredients of sugar and syrup, the second (to the right) various stabilisers, the third (lower left) water and lime juice. The descriptors (right panel) show that the first group is described with terms related to the function as a sweetener and with descriptors naming the ingredient category, while the second group is associated with words describing both the function such as consistency and glue, and the ingredient category such as stabiliser or protein. In addition, there are also words expressing lack of knowledge such as ‘unknown’, and in particular words expressing an assessment and attitude towards the ingredient using descriptors such as artificial, unnatural, harmless. The words unhealthy and processed are positioned in-between the first and the second group, indicating that they had been given to both groups. The third group is described in terms of the function of providing taste and flavour, describing the category such as water and lime, and expressing an opinion such as basic, healthy and natural. Thus, the first and second appear to contain more negatively perceived ingredients, while the third is more positively associated.

Insert Figure 2

3.1.3 Soy-free protein drink

The categorisation of the protein drink ingredients showed three groups of ingredients (left panel, Figure 3). The first group (in the upper left quadrant) contains oat base and potato protein, the second (upper right) juices, and then the third group is ginger extract and natural flavour as single ingredients (in the lower half). Descriptors (right panel) of the first group name the function, such as filling or consistency, or ingredient type, such as protein, but they also express an assessment such as basic. The second group emerges with descriptors describing the kind of ingredient, such as juice, liquid, fruit, or plant, as well as an assessment, such as healthy, good, or natural, but the function for sweetening is also commented on. The two other ingredients forming the third group, ginger extract and natural flavour, appear to be understood by its function for taste and flavour in the first case, and described by an assessment as processed and unknown in the second case. Thus, the second group appears to be perceived positively, and the first and third neutral or tentatively negative.

Insert Figure 3

3.1.4 Meat-free sausage

The categorisation of the ingredients for the meat-free sausage did not result in as clear ingredient groups ass for the other product categories, but it nevertheless shows roughly three groups (left panel, Figure 4). There is a first group of ingredients (in the upper left) composed, for example, of salt, onions and herbs, while there is a second group (in the upper right) containing stabilisers and starches. Caramel, glucose and rapeseed oil are situated towards the middle, less correlated to the perceptual space. There is a third group (in the lower half) containing gluten, wheat, and potato ingredients, with tap water situated above it. The descriptors (right panel) show that the first group is described by its taste and flavour functions, described with the kind of ingredient such as vegetable and spices, and assessed as natural and healthy. The second and larger group is described with words expressing lack of knowledge, such as unknown, of the function, such as texture, consistency and glue, but primarily with words expressing opinion and assessment, such as unhealthy, avoid, processed, unnecessary, and even dangerous or bad. The ingredients in the third group are denominated by its type, such as potato, wheat, fibre or starch, its function, such as filling, thickening, and substitute, and by an assessment, such as good or basic. Thus, the first and third group appeared more positively, while the second group appeared to be perceived more negatively.

Insert Figure 4

3.2 Differences depending on communication framing

Results from the superimposed MFA maps for the groups with differing communicational framing show that between the experimental groups, there were no important differences in the categorisation and perception of the ingredients. Figures 5 and 6 visualize this for the two products with a larger amount of ingredients (gelatine-free candy and meet-free sausage). For the other two product categories, differences were too small to visualise them in this way as the three evaluation points fell in the same place in the superimposed maps.

Differences between the experimental groups were further inspected with Chi-square tests per cell; this showed some interesting differences for the frequency with which certain descriptors were mentioned. This suggests that consumers perceived the ingredients similarly in terms of groupings and distance, but there were some differences when explaining those groups. In the following, only significant differences at $p < 0.001$ are described.

Insert figures 5 and 6

For the *gelatine-free candy* (see Table 4), the descriptors 'additive, artificial, taste, plant' are used more often when the product was presented as contributing to sustainability, while the terms 'flavouring, candy, syrup, unhealthy' were used less often. Meanwhile, when the product was presented as healthy, the associations of 'processed, hardener, extract, function, weird' were used more often, while 'taste' was used less frequently. In the experimental group presenting the product as potato based, the descriptors 'consistency, healthy, unhealthy, unnatural' emerged more frequently compared to the other groups, and the word 'plant' less often.

For the *meat-free sausage* (see Table 4), the terms 'modified, taste' were used more frequently by respondents in the experimental condition presenting the products as sustainable, while respondents were less likely to use 'fibre, flavouring, unhealthy'. In the experimental group presenting the product as more healthful, the descriptors 'extract, other, processed, spices, unhealthy' emerged more often, while 'consistency' was mentioned less often. Finally, in the group framing the product as potato based, the words 'consistency, fibre, flavouring, and unnecessary were used more frequently and the descriptors 'taste, unknown' less frequently.

For the *dairy-free ice cream* and the *soy-free protein drink*, given the lower number of descriptors and the differences between the experimental groups not being particularly marked, a smaller number of significantly (in-)frequent descriptors are observed (see Table 4). For the ice cream, 'artificial' was mentioned more often in the experimental group with products presented as sustainable, while 'lime' was more frequently mentioned in the group with products presented as healthy. For the protein drink, 'healthy' appeared more often in the experimental group with products described as potato based.

Insert Table 4

Overall with regard to research question 2, the results thus show that only minor differences emerge. Thus, the product's ingredients are perceived and categorised in a similar way no matter how the product is presented in terms of the benefit that it entails. There are, however, significant differences in the frequency of certain descriptors. Comparing across the product categories (e.g. only taking into account observations that hold for more than one product category, see Table 4), it appears that in the sustainability framing, the words 'taste' and 'artificial' are used more, while 'flavouring' and 'unhealthy' are used less frequently. In the health framing, the descriptors 'processed' and 'extract' are used more frequently, and in case of mentioning the potato source of the protein, the word 'consistency' is likely to appear than in the other communicational framing. Thus, the different communicational framing of products as sustainable, healthy or potato based had only a minor impact on categorisation and perception of ingredients, but some differences that are common across product categories indicate differences in consumer consideration of taste function in the sustainability framing, degree of processing in the health framing, and the function of providing consistency when potato as a source of protein is made explicit.

4. Discussion

The findings confirm a number of observations from previous research. Firstly, a particularly important distinction for categorising ingredients appeared to be the specific function of the ingredient in the product. More concretely, the function of providing flavour was used most frequently and resulted in an own category of ingredients, typically positively associated. Thus, the flavour function is perceived as positive – as long as it is not sweetness as such. This observation might be explained by the importance that taste as a food product quality has for consumers, despite the increasing interest in credence attributes of food such as

sustainability and health (Grunert, 2002; Grunert, 2005): Quite often taste is the most important driver of consumer food choice and purchase motives. Interestingly, the flavour-providing ingredients in the four product categories tended to be perceived as natural and healthy. However, the latter might be due to the fact that the product examples were chosen to be from among cases of plant-based and 'free-from' products.

Secondly, the results confirm that protein is indeed an ingredient with a rather positive image (Alting & van de Velde, 2012). It is regarded as a natural ingredient serving the function of 'filling' and is assessed as rather harmless and basic, not resulting in any negative associations. Possibly this is due to it being understandable and mentioned in connection with other plant-based ingredients, at least in the ingredient list of the products studied. Interestingly, no association of potato as being high in carbohydrates emerged, as some research into potato protein in specific would suggest (Clarke & Best, 2017; Wood et al., 2017). However, the communication framing presenting products as potato protein based led consumers to use the word 'consistency' more often, which might show that they speculated about the function of potato protein in this context.

Thirdly, the study findings support previous research showing that consumers frequently have negative associations towards certain nutrient groups which they regard as unhealthy, and that they are avoiding certain groups more than they seek others in what might be a 'negativity bias' (Rozin & Royzman, 2001; Scarborough et al., 2015). In accordance with Song and Swartz (2009), consumers perceived ingredients as more risky when they were not familiar with the ingredient. The ingredient group of sugar and syrups was assessed negatively and primarily unhealthy. It appears to be an ingredient group well understood and categorised as distinct by consumers as it showed a clear distance to other groups and homogeneity in the descriptors.

Fourthly and as an overall observation, the underlying assumption of 'clean label' as a trend (Ingredion, 2014) is found to be mirrored in the results. Thus, unknown ingredients are perceived negatively and are regarded dubious or as potentially risky; there is an apparent connection between ingredient groups described as unknown and also denoted as processed, artificial, chemical, dangerous, unnatural and unnecessary (Asioli et al., 2017). Avoidance of chemically perceived ingredients (Dickson-Spillmann et al., 2011), the 'modern health worries' of consumers (Devcich et al., 2007) and the preference for natural and avoidance of added ingredients (Scott & Rozin, 2017) seem to be underlying drivers of this negative

perception of ‘un’-ingredients (e.g. ingredients that receive descriptors starting with un-, such as unknown, unnatural, unnecessary, etc.). Interestingly, the results indicate that under a health frame, consumers especially focus on the degree of processing across product categories, given they used the descriptors ‘processed’ more often.

Fifth and finally, some differences in frequency of use of descriptors emerge. The exact reasons for the differences triggered by the different communicational framing can only be speculated and leave room for future research. However, it might show that the sustainability benefit leads consumers to consider whether the product is tasty nevertheless (thus using a descriptor on ‘taste’ more often, but the assessment as ‘unhealthy’ less often). The health benefit, in turn, underlined in the communication might trigger consumers to inspect whether ingredients are healthy or not, using in particular the degree of processing as a cue (thus using the respective descriptor ‘processed’ more often). Finally, when the focus was on the plant-based substitute ingredient, more descriptors related to the ingredient function were mentioned (using the descriptor ‘consistency’ more often).

4.1 Implications for food producers and policy makers

A number of strategies could avoid that ingredients are negatively associated. One of the strategies could be to remove words from the ingredient name that are not well understood (in the current study e.g. ‘modified’ from starches, given starches are perceived neutral to positive, or ‘stabiliser’ from potato protein, as the word seems to make an ingredient appear mixed rather than positive). The second strategy could be adding words to the ingredient name which positions the ingredient more positively (in the current study, e.g., ‘potato’ to starches, or ‘pea protein’ to hydrolysate). This is in line with findings from previous research on very similar ingredient wordings showing that ‘modified potato, tapioca or corn starches’ are rated more favourably than the generic term ‘modified starch’ (Varela & Fiszman, 2013). In particular specifying an ingredient as a known plant-based ingredient that consumers are likely to categorize and perceive as known and natural would be a good strategy (as for example specifying or exchanging ‘natural flavour’, which is perceived as processed, for a known, plant-based ingredient providing natural flavour). The third strategy could be to make ingredients, which consumers – once they become familiar with the ingredient– would very likely perceive as harmless, known and natural, more known by communication efforts or an explanation on the package (as, for example, the ingredients of carob seed and carob bean).

Such a strategy has been suggested for food hydrocolloids yet unknown, but in fact natural in their origin (Varela & Finszman, 2013).

A fourth strategy might entail ensuring that the ingredients indicate a consumer-oriented benefit rather than a producer-oriented benefit. This observation has emerged previously in qualitative research on perception of innovative technologies in food processing (De Barcellos et al., 2010; Hung et al., 2016). It might be explained on the background of consumers' anti-profit beliefs, assuming that company endeavours have negative consequences (Bhattacharjee, Dana, & Baron, 2017). The observation in this study that 'known' ingredients are perceived more favourable might ultimately be related to that greater interest and attention is paid to ingredients which have a benefit for the consumer. The implication is that ingredients which are negatively perceived by consumers but needed in the product, should be explained in a better and more convincing manner and ideally with a focus on the consumer benefit. This would improve acceptance of such an ingredient and ensure its acceptance as 'clean' on the label.

For the case of potato protein as a new alternative ingredient, the findings imply that consumers categorize it as protein and perceive it as favourable. Communicating the potato origin of the protein more clearly to the consumer does not entail any negative perceptions according to the study findings. Consumers appear to explain the role of the potato protein with providing consistency to the food.

For policy makers, the results highlight consumer scepticism towards any ingredient perceived as unknown or unnatural. This underlines that nutritional education is important. However, it might be even more impactful to secure the legal use of ingredient names which consumers perceive as harmless, in particular for ingredients for which it is scientifically substantiated that they are in fact harmless. Ensuring a good understanding of the type of ingredient in question and in particular the function that it plays in the product would help to avoid that safe and harmless ingredients fall into the 'un'-perception and downward spiral from unknown to unnatural to unnecessary.

4.2 Limitations and future research

It should be noted, of course, that the categorisation consumers apply might entail misunderstandings or a lack of knowledge on the function of an ingredient. In addition, that a

natural-sounding ingredient in fact has undergone less processing than some other, strangely sounding ingredient which seems to receive associations of being chemical and artificial, is only an assumption consumers make. Also, consumers perceive natural as better and less risky, but it does not necessarily mean it is (Burdock & Wang, 2017).

Overall, the study represents a sample of the potential target group, but nevertheless a limited group of consumers on the Danish market – possibly results in other cultural contexts and food market environments are different (Ares, 2018). Further variables of relevance – as, for example, health concern or sustainability interest – ought to explain individual differences in greater depth. The findings pertain to plant-based 'clean label' ingredients, for which food producers likely select ingredients in a similar fashion. For example, the finding of flavour ingredients perceived as favourable has a lot to do with these flavour ingredients being naturally sounding. It can thus not be generalised to non-'clean-label' foods. Future research might compare food products from other and contrasting groups of foods, as, for instance, an unhealthy, processed convenience food with no clean-label positioning to identify how consumer categorisation of ingredients differs as compared to clean label foods. Furthermore, future studies could quantify the findings for a more generalizable sample, or across different countries.

5. Conclusions

From the exploratory results it can be concluded that consumer categorisation and perception of ingredients appear largely in line with what the clean label trend leads food producers to expect. This applies to the four plant-based products which are 'free-from' a certain ingredient, thus part of the clean label trend. The explorations show that consumers categorise into roughly three groups of ingredients, and they use three underlying distinctions in doing so, i.e. the category type to which the ingredient belongs, the function that it has in the product, and how the consumer assesses it, e.g. as positive or negative. More specifically, it can be concluded that sugar and syrups are ingredients which are grouped jointly and perceived as unhealthy, while flavour-providing ingredients are grouped by their taste function and perceived as basic, natural and often as healthy as well. Protein, which was the focus of this study, is primarily perceived as harmless, basic and natural.

Just as the clean label definition suggests, there is a clear tendency to group the 'remaining' ingredients into a heterogeneous cluster. This heterogeneous cluster is then described with a

variety of functions of ingredients to the extent that consumers can identify them, but a particularly frequent assessment is that the ingredients are unknown. We conclude that the exploratory research findings show that consumers tend to follow a 'line of reasoning' from the unknown to unnatural and unnecessary, and ultimately often to the unhealthy. We conclude that based on our findings, different communicational framing appears to have only a minor impact on consumer categorisation and perception, most notably in terms of healthy products inspected more closely with regard to the processing of ingredients, and potato-containing foods assessed with regard to the consistency function of ingredients.

In sum, the study shows that a closer exploration of consumers' categorisation and perception of ingredients can help to understand how consumers perceive products within the 'clean label' trend. The categorisation into 'known-natural-good' versus the opposite is found to hold true for the consumers represented in this study, and for the products explored.

Tables and figures

Table 1. Communicational framing of the product concepts towards sustainability, health and plant-based products containing potato protein.

Group 1: "Plant-based food products, which means products that do not contain any ingredients from animals, are increasingly demanded in the market place, because they contribute to a more sustainable lifestyle. By eating less animal-based products, we can contribute to reducing greenhouse gas emissions and thereby reduce our own negative impact on climate change."
Group 2: "Plant-based food products, which means products that do not contain any ingredients from animals, are increasingly demanded in the market place, because they contribute to a healthier lifestyle. By eating less animal-based products, we consume less saturated fatty acids, which has been found to prevent cardiovascular diseases and some forms of cancer."
Group 3: "Plant-based food products, which means products that do not contain any ingredients from animals, are increasingly demanded in the market place. Potato proteins have been found to be a useful substitute for animal-based ingredients in a range of products."

630 **Table 2. Stimuli used in the task: ingredient lists of the food products**
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Product	Ingredient list
gelatine-free candy	glucose syrup, white sugar, glucose fructose syrup, modified starches, liquorice root extract juice, brown sugar syrup, thickening agents (carob bean gum, xanthan gum), vegetable protein (potato protein), flavouring substances, citric acid, elderberry juice concentrate, salt, pea protein hydrolysate, sunflower seed oil, glazing agents (beeswax, beeswax)
dairy-free ice cream	water, peeled lime juice (27%), sugar, corn glucose syrup, invert sugar syrup, stabilisers (carob seed flour, pectin, potato protein)
soy-free protein-drink	oat base (water, oat (11%)), apple juice (33%), beetroot juice (23%), potato protein, lemon juice, natural flavour, ginger extract
meat-free sausage	tap water, wheat protein, onion, rapeseed oil, peppers, potato starch, inulin, gluten, spices (mustard flour), glucose, salt, potato flake, modified starches, potato fibre, potato protein, stabiliser (calcium chloride, sodium alginate), caramel III, herbs

632

633 **Table 3. Projective mapping instructions**

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"We would like you to do a sorting task of ingredients. For this task, there are no right and no wrong answers, and we are interested in your spontaneous groupings. I will now show you four lists of ingredients of plant-based products and I would like you to take the ingredients and sort them as you see fit. Group those ingredients together that you feel are closest related. Place them on the piece of paper according to the strategy that two ingredients placed closer to each other are more alike than two ingredients placed further apart. The criteria for how to sort the ingredients just have to make sense to you. In this way, there are only right solutions. Please use the tape to stick the ingredients on to the paper. When you are done with the sorting task, please write down a few words describing why you placed these ingredients together. For example, on this map, there are different shapes and one possible way to group them is like this (show solution 1) – or one could also group the shapes like this (show solution 2) or in another way. Again, there are no right or wrong solutions, we are interested in your subjective perception of the ingredients. Do you have any questions? Please begin."

635

Table 4. Descriptors used more or less frequently (than the expected theoretical value, coming from Chi-square per cell analysis, with p < 0.001).

Gelatine-free candy		
	More frequent descriptors	**Less frequent descriptors**
Sustainable group 1	additive, artificial, taste, plant	flavouring, candy, syrup, unhealthy
Healthy group 2	processed, hardener, extract, function, weird	taste
Potato group 3	consistency, healthy, unhealthy, unnatural	plant
Meat-free sausage		
	More frequent descriptors	**Less frequent descriptors**
Sustainable group 1	modified, taste	fibre, flavouring, unhealthy
Healthy group 2	extract, other, processed, spices, unhealthy	consistency
Potato group 3	consistency, fibre, flavouring, unnecessary	taste, unknown
Dairy-free ice cream		
	More frequent descriptors	**Less frequent descriptors**
Sustainable group 1	artificial	
Healthy group 2	lime	
Potato group 3		
Soy-free protein drink		
	More frequent descriptors	**Less frequent descriptors**
Sustainable group 1		
Healthy group 2		
Potato group 3	healthy	
Emerging in two product categories		
	More frequent descriptors	**Less frequent descriptors**
Sustainable group 1	taste, artificial	flavouring, unhealthy
Healthy group 2	processed, extract	
Potato group 3	consistency	

Figure 1 a). Perceptual space determined by the first two factors of the MFA in the projective mapping task (consensus plot – all consumers) gelatine-free candy

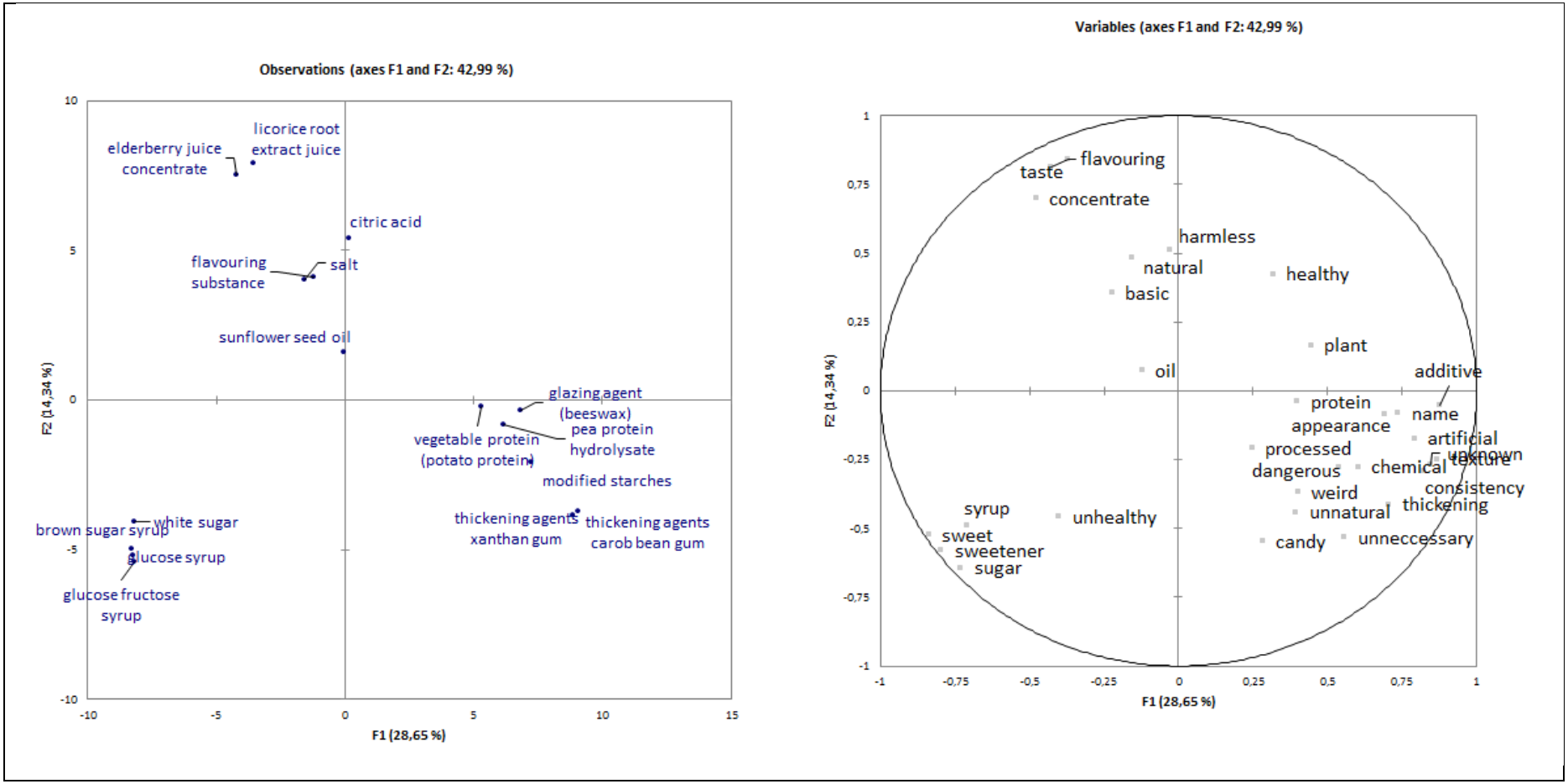


Figure 1 b). Perceptual space determined by the first factors 1 and 3 of the MFA in the projective mapping task (consensus plot – all consumers), gelatine-free candy

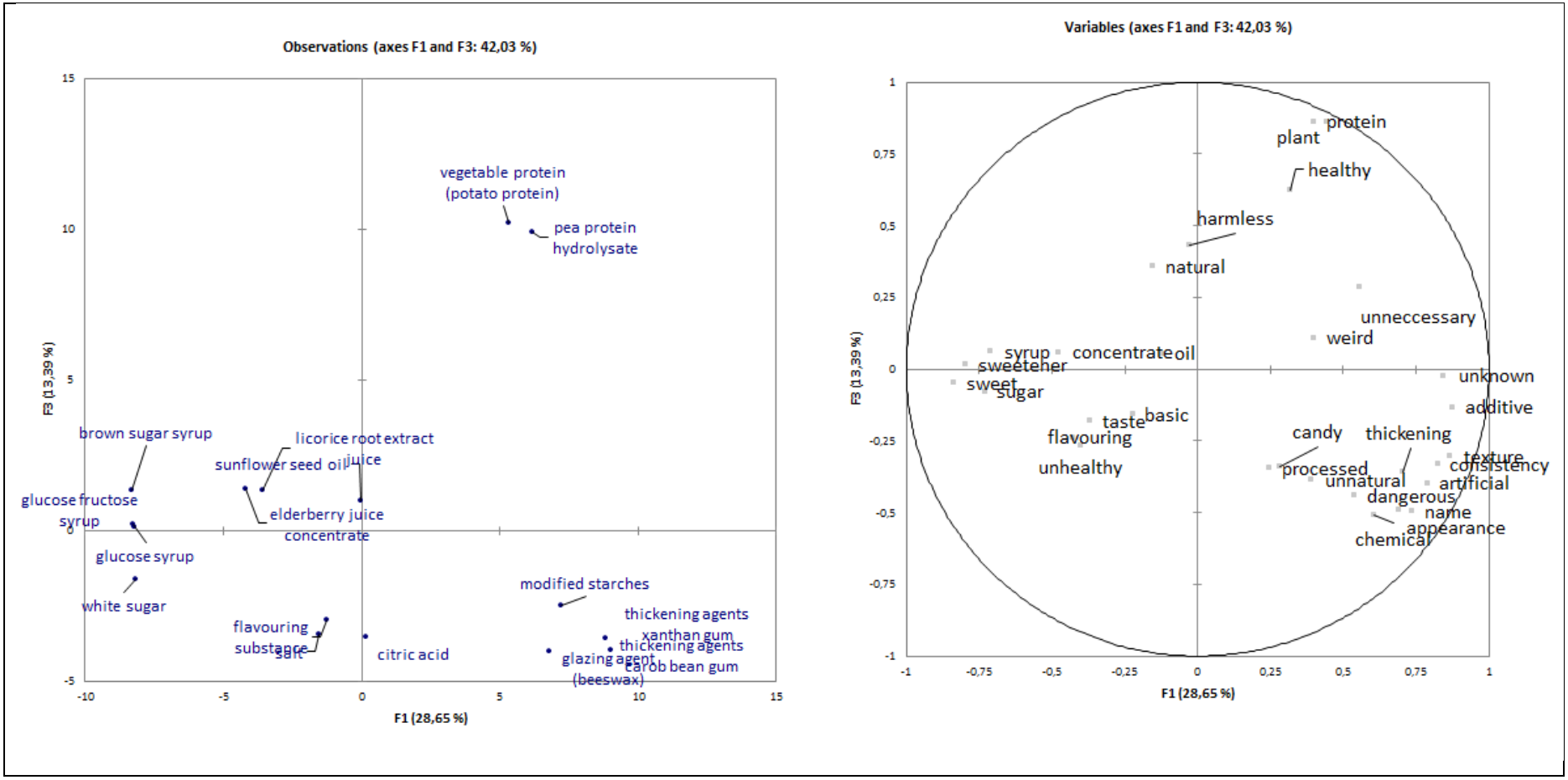


Figure 2. Perceptual space determined by the first two factors of the MFA in the projective mapping task (consensus plot – all consumers), dairy-free ice cream

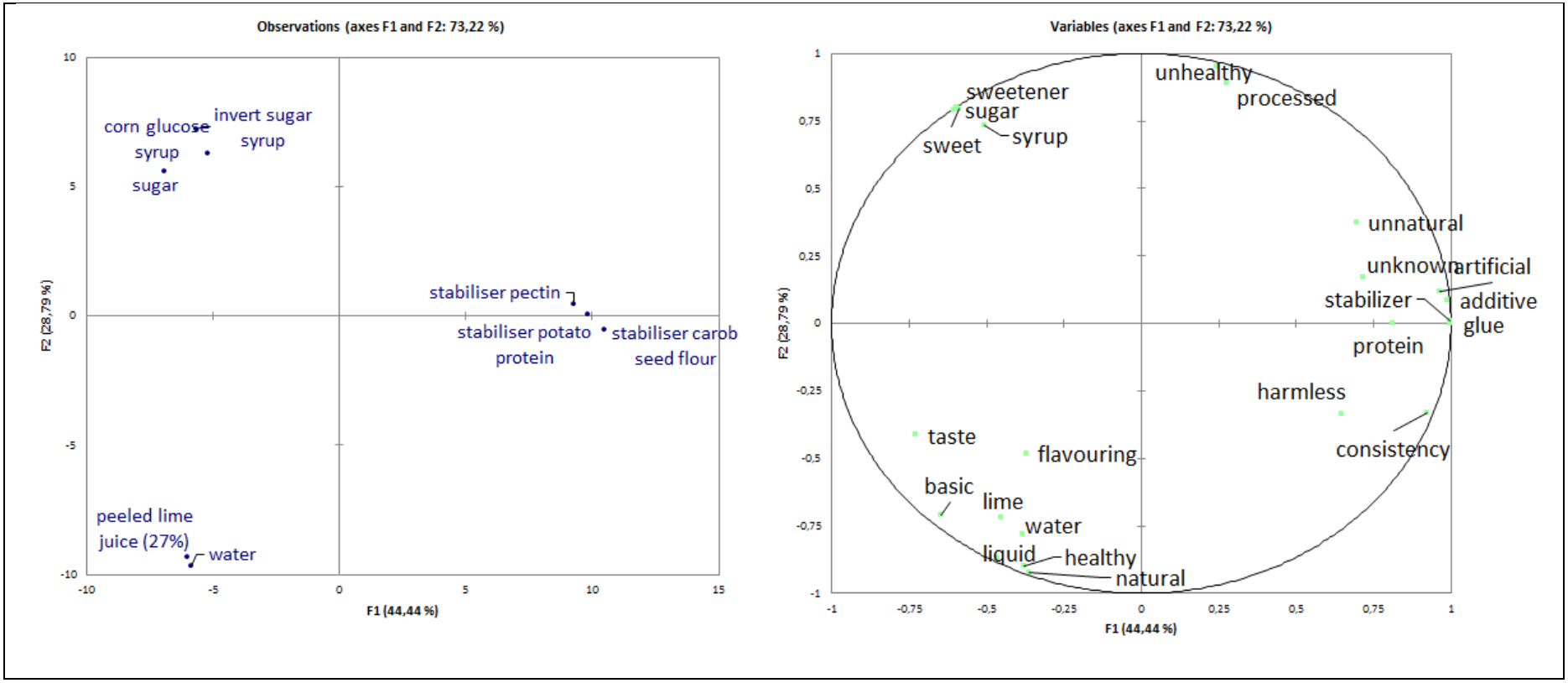


Figure 3. Perceptual space determined by the first two factors of the MFA in the projective mapping task (consensus plot – all consumers), dairy and soy-free protein drink

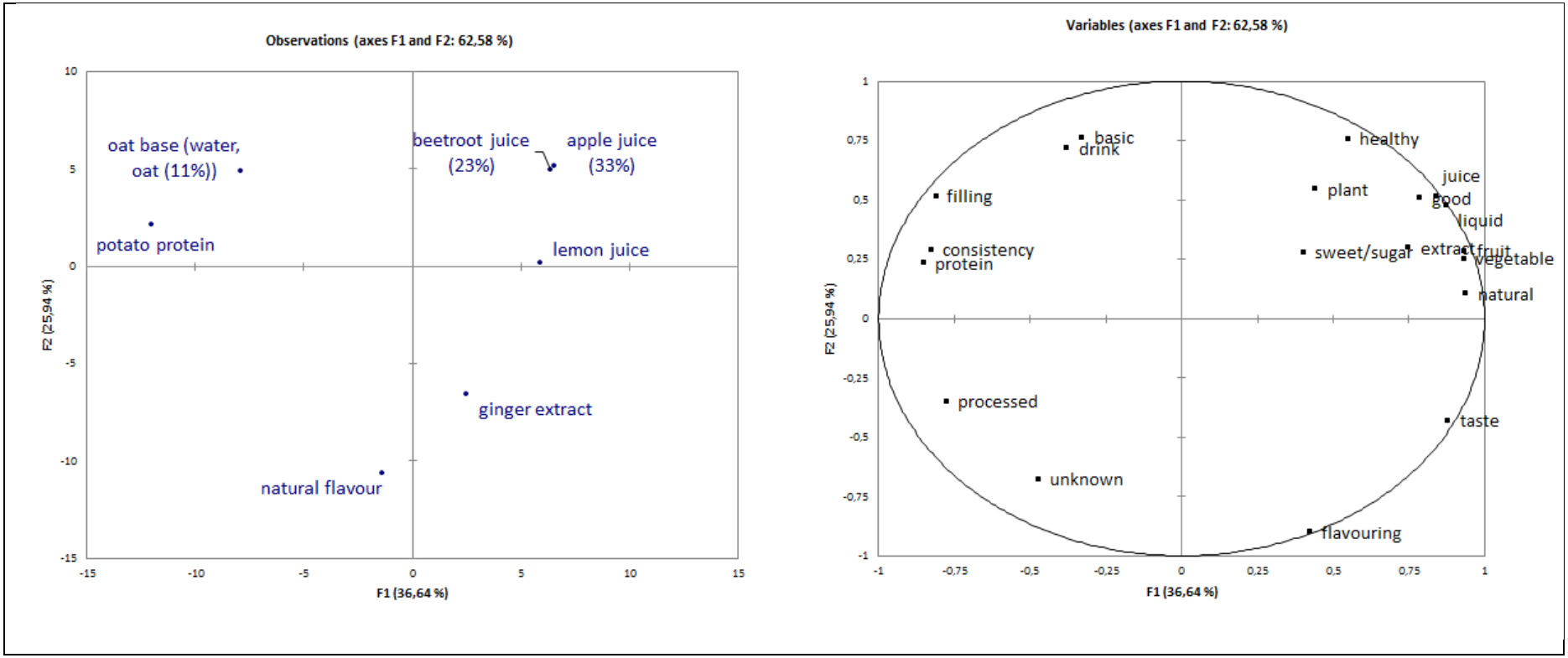


Figure 4. Perceptual space determined by the first two factors of the MFA in the projective mapping task (consensus plot – all consumers), meat and egg-free sausage

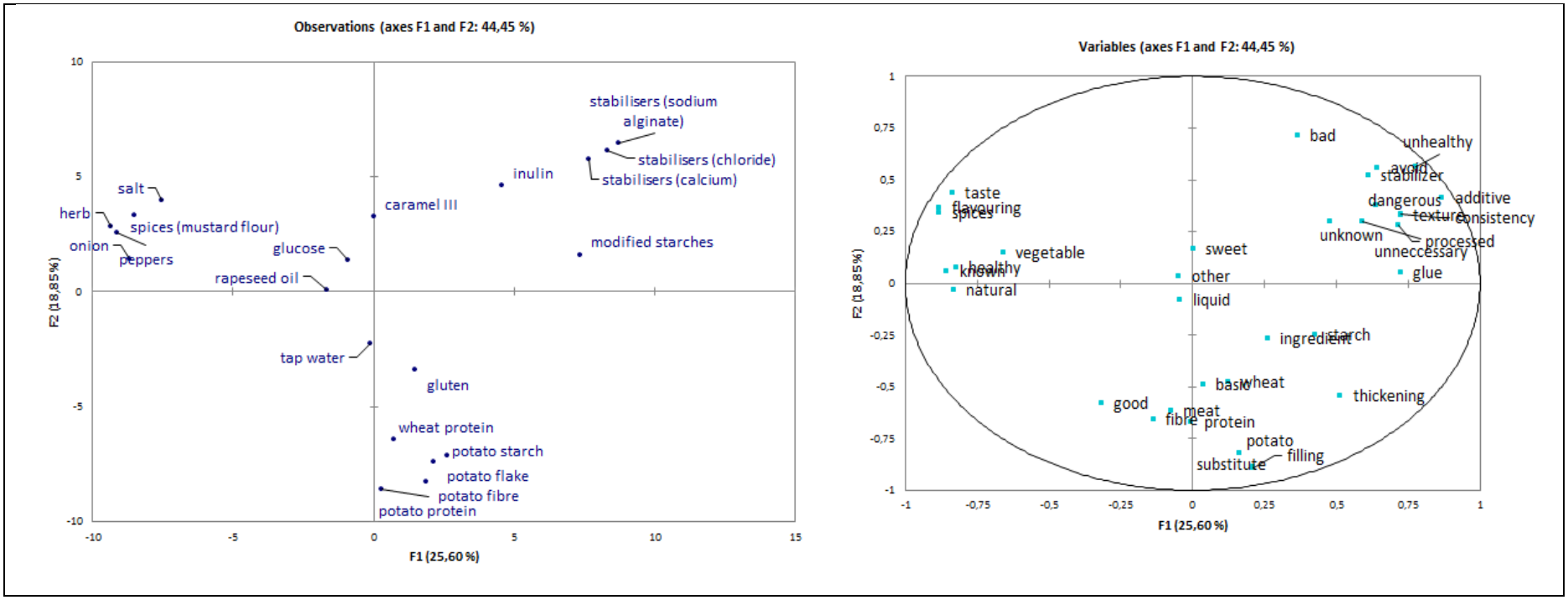
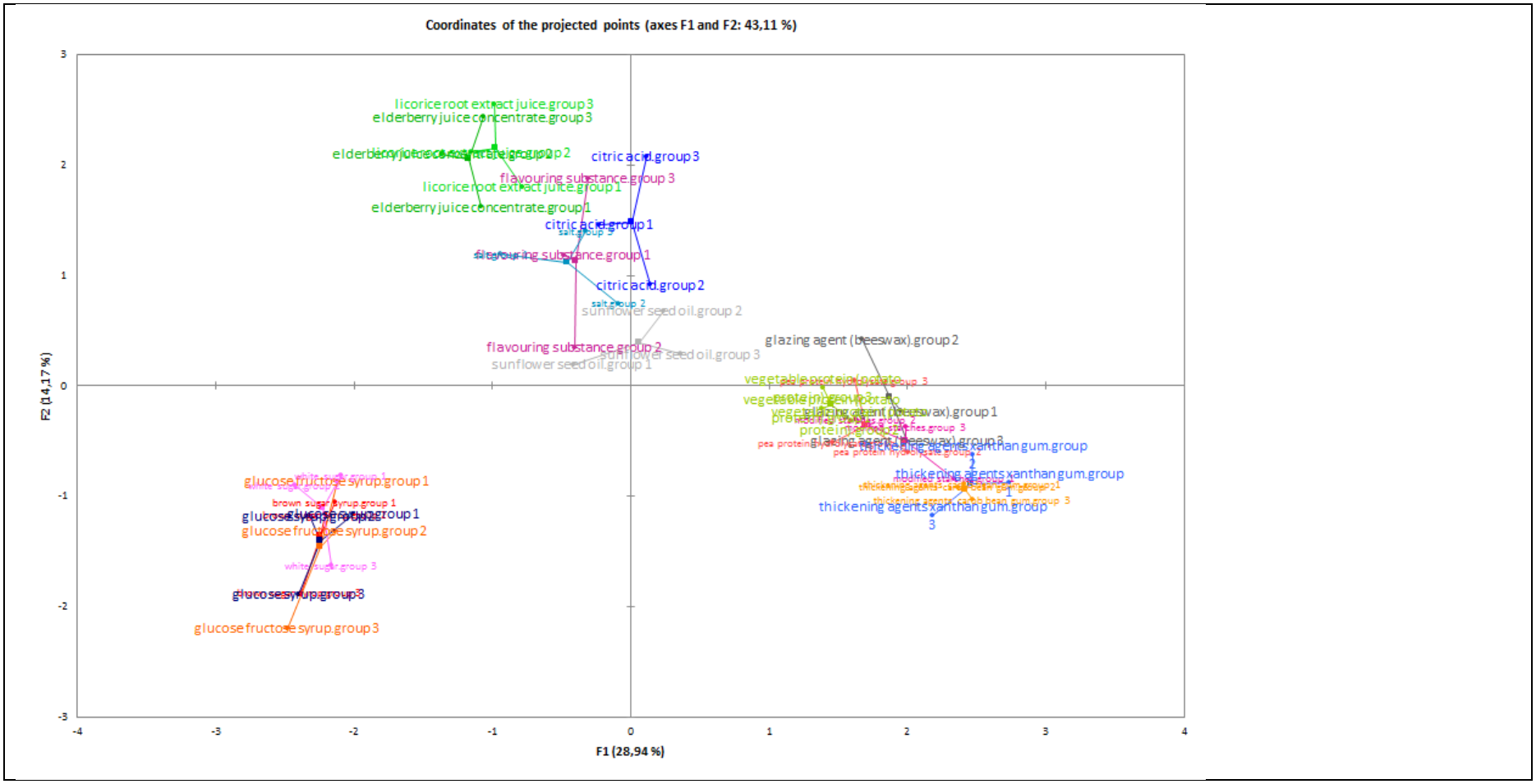
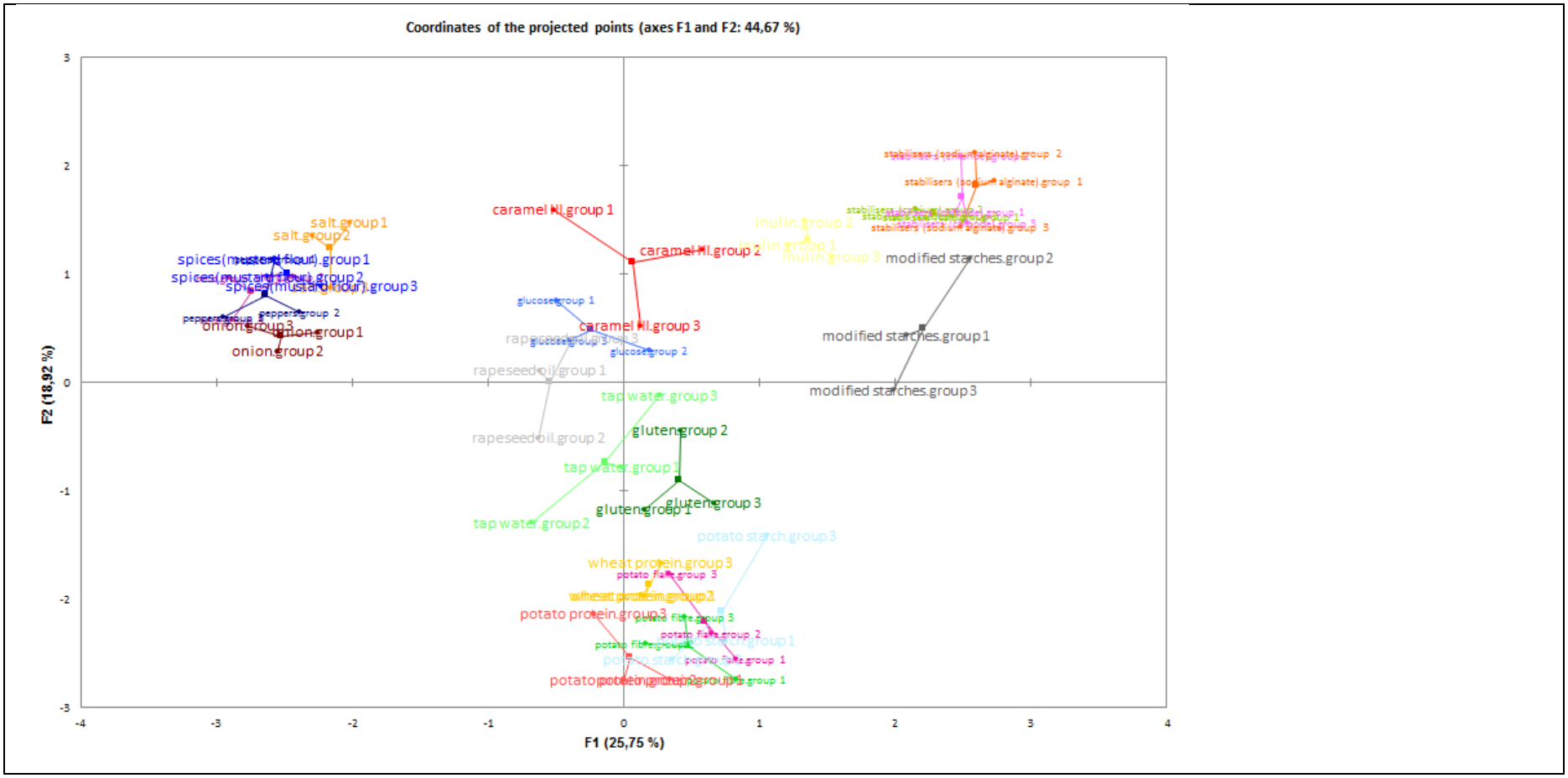


Figure 5. Superimposed representation of the products in the Multi Factor Analysis (MFA), gelatine-free candy



Note: Each sample is represented using three points corresponding to each framing group, the consensus representation is depicted by the middle point. Group 1 = sustainable, group 2 = health, and group 3 = potato.

Figure 6. Superimposed representation of the products in the Multi Factor Analysis (MFA), meat-free sausage



Note: Each sample is represented using three points corresponding to each framing group, the consensus representation is depicted by the middle point. Group 1 = sustainable, group 2 = health, and group 3 = potato.

Supplementary tables

Table A. Frequency of descriptors when comparing the experimental groups for gelatine-free candy

	additive	artificial	processed	consistency	hardener	flavouring	taste	extract	candy	function	healthy	plant	syrup	unhealthy	unnatural	weird
Sustainable group 1	136 (+) ***	16 (+) ***	6	14	0 (-) *	25 (-) ***	53 (+) ***	0 (-) **	3 (-) ***	0 (-) *	2 (-) *	17 (+) ***	0 (-) ***	0 (-) ***	11	4
Healthy group 2	23 (-) ***	3	19 (+) ***	11 (-) *	10 (+) ***	61	22 (-) ***	15 (+) ***	28	14 (+) ***	3 (-) *	6	11	22	11	20 (+) ***
Potato group 3	23 (-) ***	0 (-) **	5 (-) *	33 (+) ***	0 (-) *	72 (+) **	42	0 (-) **	35 (+) **	0 (-) **	18 (+) ***	0 (-) ***	17 (+) **	39 (+) ***	30 (+) ***	2 (-) **

(+) or (-) indicate that the observed value is higher or lower than the expected theoretical value. *** $p < 0.001$,** $p < 0.01$ and * $p < 0.05$; effect of the chi square per cell. Only descriptors which show a significance on a $p < 0.001$ level in at least one group are shown.

Table B. Frequency of descriptors when comparing the experimental groups for meat-free sausage

	consistency	extract	fibre	flavouring	modified	other	processed	spices	taste	unhealthy	unknown	unneccessary
Sustainable group 1	11	0	0 (-) ***	10 (-) ***	11 (+) ***	4	5 (-) *	16	64 (+) ***	0 (-) ***	29	6
Healthy group 2	3 (-) ***	9 (+) ***	14	32	0 (-) *	12 (+) ***	26 (+) ***	40 (+) ***	35	32 (+) ***	42 (+) **	5 (-) *
Potato group 3	32 (+) ***	0 (-) *	27 (+) ***	61 (+) ***	0 (-) **	0 (-) **	13	20 (-) *	35 (-) ***	25	22 (-) ***	27 (+) ***

(+) or (-) indicate that the observed value is higher or lower than the expected theoretical value. *** $p < 0.001$,** $p < 0.01$ and * $p < 0.05$; effect of the chi square per cell. Only descriptors which show a significance on a $p < 0.001$ level in at least one group are shown.

671 **Table C. Frequency of descriptors when comparing the experimental groups for dairy-free ice cream**

	artificial	consistency	harmless	lime	stabilizer	unhealthy
Sustainable group 1	11 (+) ***	6	0 (-) *	1 (-) *	36 (+) **	8
Healthy group 2	0 (-) **	7	9 (+) **	13 (+) ***	21	1 (-) **
Potato group 3	5	22 (+) **	3	3	30	18 (+) **

(+) or (-) indicate that the observed value is higher or lower than the expected theoretical value. *** $p < 0.001$,** $p < 0.01$ and * $p < 0.05$; effect of the chi square per cell. Only descriptors which show a significance on a $p < 0.001$ level in at least one group are shown.

672

673 **Table D. Frequency of descriptors when comparing the experimental groups for soy-free protein drink**

	extract	good	healthy	protein	taste
Sustainable group 1	0 (-) **	0 (-) *	6	14	20
Healthy group 2	4	8 (+) **	3 (-) *	22 (+) *	35 (+) **
Potato group 3	12 (+) **	2	20 (+) ***	9 (-) **	21 (-) *

(+) or (-) indicate that the observed value is higher or lower than the expected theoretical value. *** $p < 0.001$,** $p < 0.01$ and * $p < 0.05$; effect of the chi square per cell. Only descriptors which show a significance on a $p < 0.001$ level in at least one group are shown.

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