French consumers know the benefits of pulses, but do not choose them: An exploratory study combining indirect and direct approaches

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Introduction

Pulses have been cultivated for the past 11 000 years (Fortin, 2006), but have attracted far more attention over the last decade, because of their great potential to increase global food security and enhance environmental sustainability. According to the Food and Agriculture Organization (FAO), pulses are leguminous crops harvested exclusively for dry seed (i.e. dried beans, lentils, and peas), but excluding crops used mainly for oil extraction, e.g. soybeans, and those that are harvested green, e.g. green peas (FAO, 2016). Deep roots allow pulse plants to adapt to unfavorable conditions (Iriti & Varoni, 2017), so that they can be cultivated almost everywhere. Pulses are unique in the vegetable kingdom in that they fix nitrogen from the atmosphere, fertilizing the soil, and therefore increasing biodiversity (FAO, 2016; Schneider et al., 2015). In addition to these positive consequences for the environment, pulses present several advantages from a nutritional point of view. Many national and international authorities now highlight the benefits of regular human consumption of pulses. The United Nations declared 2016 to be the International Year of Pulses, under the slogan “nutritious seeds for a sustainable future” (FAO, 2016).

Besides being a major source of plant-based proteins, pulses are rich in dietary fibers, complex carbohydrates, minerals, and vitamins, an almost ideal basis for a healthy diet (Curran, 2012; Mudryj, Yu, & Aukema, 2014). Increasing pulse consumption to four times per week or more has been associated with a reduced risk of coronary heart disease (Bazzano et al., 2001). The high fiber content of pulses may have positive effects on short-term satiety (McCrory, Hamaker, Lovejoy, & Eichelsdoerfer, 2010), and weight loss. Pulse consumption can also present health benefits for specific populations. Frequent consumption of pulses, especially lentils, helps to prevent type 2 diabetes in older adults because of the low glycemic index (Becerra-Tomás et al., 2017). Folate, a vitamin present in pulses, reduces the risk of neural illness in newborn babies, while iron, a mineral also present in pulses, is known to prevent anemia in women, children, and babies (FAO, 2016).

Despite these benefits, pulse consumption in France has declined, from 7.2 kg in 1920 to 1.7 kg per person per year in 2016, although health authorities recommend eating pulses at least twice a week (ANSES, 2017a; HCSP, 2017). Some hypotheses to explain low consumption in France are related to consumer issues, e.g. poor knowledge of pulses, bad memories of pulses at the school canteen; the need to plan ahead for pre-soaking, or the lack of recipe ideas and motivation (Lecerf, 2016). Cultural prejudice against pulses, seen as “the poor man’s meal”, might also explain low consumption (Magrini, 2016; Rio, 2017). Packaging-related issues may lower consumer expectations: pulses are often sold in cans, generally perceived as poor quality food, in comparison with foods in the form of prepared dishes or raw products (Champ, Magrini, Simon, & Le Guillou, 2015). Finally, other reasons could be related to the food product itself, such as the time required for soaking pulses, except for lentils (12 hours or overnight), and unwanted digestive effects, e.g. flatulence (Champ et al., 2015; Lecerf, 2016; Magrini, 2016; Rio, 2017). These hypotheses have not yet been experimentally tested, requiring new studies to validate them. No scientific study to date has directly investigated mental representation of pulses among consumers in France.

In a French study, declared consumption of pulses was significantly higher (0.3 times more) in men than in women (CREDOC, 2007). Different consumer profiles in relation to pulses have also been reported in countries other than France. In Finland, frequent consumption of beans was significant in young consumers (25-34 years old), and in consumers with a high level of education (Jallinoja, Niva, & Latvala, 2016). In Canada, pulse consumption was low among young Canadians (18-34 years old), and people living alone, but higher among consumers with a university education (IPSOS, 2010). Such studies, assessing consumption or willingness to consume specific products, are usually based on direct, declarative methods (web-based surveys, online interviews, or focus groups). One possible limitation of declarative methods is the potential dissociation between what participants think or say about their behavior and what they actually do (Köster, 2003).

Mental representations of food play an important role in consumer behavior and may affect inference, judgment, and food-product choice (Bartels & Johnson, 2015). Better knowledge of such mental representations may help to develop strategies to increase pulse consumption in France. A mental representation is an image that an individual has of a product, a person, an idea, or a situation. According to Gallen (2005), representations are defined as cognitive products and individual mental processes that come from the interaction of individuals with their environment, allowing them to code the meaning of the stimuli and store this information in memory. Consumers' mental representations can be investigated through direct (i) or indirect (ii) methods.

(i) Direct methods are typically questionnaires or surveys that ask people to describe their choices or the reasons for their choice, to gather information about their attitudes and behaviors. In direct methods, the questions focus on the main goal of the study, which generally results in consumers becoming aware of the research objective. Among potential biases linked to surveys and questionnaires (Mathers, Fox, & Hunn, 2009), the best known is social desirability bias, where participants seek to present a positive image of themselves to the researcher. Participants thus tend to "under-report socially undesirable attitudes and behaviors and to over-report more desirable attributes" (Latkin, Edwards, Davey-Rothwell, & Tobin, 2017). Answering a questionnaire is a complex cognitive task: it implies understanding the meaning of the questions, accessing information stored in memory, adapting this information to the situation, and then estimating the reliability of the chosen answer in relation to all other possible answers (Krosnick, 1991). Participants may therefore select the first answer acceptable to them without going through the entire cognitive process.

(ii) In contrast, indirect questioning methods are thought to provide access to “unconsciously latent psychosocial constructs” (Antonak & Livneh, 1995). In cognitive psychology, indirect tests assess the retention of information without direct reference to the source of information (Nicolas, 1994; Perruchet & Nicolas, 1998). This type of “questioning” reduces the risk of respondents becoming aware of the research objective, and thus reduces the potential bias that could be generated if the goal of the study is known. As a consequence, results obtained by indirect methods are thought to be more reliable. Rather than asking respondents directly about their behaviors and motivations, questions are formulated in terms of other people (i.e., your friend, your family, or your students) or imaginary situations (i.e., at school, at the supermarket, or in a restaurant) (Belk, 2006).

The aim of this study was to understand the representation of pulses among French non-vegetarian consumers, using both (i) an indirect approach, with a dish-composition task, based on the use of six scenarios evoking real-life situations, and (ii) a direct method, with an online questionnaire. The direct method was expected to provide access to explicit knowledge and beliefs about food-product characteristics, while the indirect method was thought likely to generate more spontaneous behaviors in relation to food choice. The representations obtained through each approach were hypothesized to be different, yet complementary. Combining these two approaches should therefore provide broader access to consumers’ mental representations of pulses. If potential barriers are identified, suitable strategies can then be developed to increase pulse consumption.

Material and methods

2.1 Participants

Participants had to be over 18 years old, with no specific or restrictive diet (e.g. vegetarian, or gluten-free), no food allergies, and no severe dislike of any foods. Another condition was that participants had to be in the habit of preparing meals several times a week, for themselves and/or their household, to avoid including people unused to composing dishes. To recruit participants, flyers were posted around the city in public places (university, gyms, libraries, and cultural centers). Those who replied were invited to attend an interview where researchers verified that all the above eligibility criteria were met, thus retaining 120 participants for the study. Table 1 gives an overview of the participants’ main characteristics. The median age was 35, and the mean age was 39, whether for men or for women. The conditions of the study were explained, and all participants signed informed consent forms before beginning the study. To ensure participation throughout the study, participants would receive 20€ each for participation only if they had completed both tests.

Please insert table 1 here

All 120 participants performed two tasks. The dish-composition task, which evoked real-life situations by means of scenarios, required participants to compose suitable dishes, using images of food products. One week later, participants were required to complete an online questionnaire, based on the same set of images.

2.2 Material

2.2.1. Construction of a set of images common to both tasks

Food images were used for both the dish-composition task and the online survey, to provide identical stimuli throughout both tasks. A set of food images was therefore constructed, taking several criteria into consideration. First, all the food products belonged to the French food repertoire, and were chosen to represent the four main categories of food recommended by the *French national health and nutrition program* (PNNS) to compose a main dish. Food products were presented in the form of raw ingredients. The MFPE group included only foods of animal origin: meat, fish, poultry, and eggs. The Pulse group was composed of dried beans, lentils, and peas. The Starch group was composed of cereals and potatoes. The Vegetable group was composed of products commonly considered as vegetables by French consumers, whatever their botanic classification (broccoli, carrots, green beans, tomatoes, and zucchini).

All food products were purchased from supermarkets, and then photographed in exactly the same conditions. An equivalent volume of each raw product was presented in the center of a white porcelain plate, on a blue background. Blue, rarely a natural food color, was chosen as the background, to create good contrast with the white plate (Charbonnier, van Meer, van der Laan, Viergever, & Smeets, 2016). All photos were taken on the same day, in the same lighting conditions. During the entire photo shoot, the angle of shooting, the distance between the center of the plate and the camera lens, the position of the plate on the table, and the table itself were maintained constant.

After the photos had been standardized via Photoshop ® (luminosity, color intensity, etc.), all twenty images were printed (9cmx13cm) and plasticized. A pre-test was carried out on a small sample of participants (n=30) to ensure that each image was identifiable, that photo quality was good, and that the amount of food was perceived as similar for each image.

2.2.2. *Creation of scenarios for the dish-composition task*

The dish-composition task used scenarios to create equal and comparable conditions for all participants. Six scenarios evoking real-life conditions encompassed the diversity of situations in which people make food choices (Table 2). The Everyday scenario was conceived as the control for this study. The Budget scenario evoked the constraints of waiting for payday. The Guest scenario placed participants in a social context. The Vegetarian scenario necessarily included a guest with a vegetarian diet, because participant selection criteria excluded vegetarians. For the no-cooking, out-of-home context, both the more ordinary Self-service scenario, and the more prestigious Restaurant scenario take into account French consumer food habits: they bring food from home for lunch 34% of the time; they often have lunch at the canteen (24%), or at fast-food eateries, pubs, and restaurants (21%); they eat at a friend or family member's house 18% of the time (ANSES, 2017a). Participants were given the written description for each scenario (Table 2), also presented orally, accompanied by the following instructions: "In this situation, compose a main dish using three images".

Please insert table 2 here

2.2.3. *Construction of the online questionnaire*

The online questionnaire was used to obtain information about each food product individually. Ten question scripts were created to obtain ratings of different food properties by means of a 5-point ordered category scale (Table 3).

Please insert table 3 here

2.3. *Procedure*

2.3.1. *Indirect approach: Dish-composition task*

All sessions were individual, lasted about 45 minutes, and took place in the laboratory. Images were placed on a table in front of the participant, in the form of a randomized 5 x 4 rectangle (Figure 1), to avoid any effect of order or position. The experimenter asked the participant to identify each food in the images, before presenting the first scenario and asking the participant to compose a main dish, using only three images, although four food groups were represented. This parameter was used to obtain information about the relative importance of each food group for the participant.

After putting the cards back on the table, participants were asked to compose another dish for the same scenario, without using the same picture triplet. For each scenario, each participant composed five dishes. Once five dishes had been created, a new scenario was presented, with the same instructions. The order of the scenarios was randomized for each participant so as not to bias the results by an order effect.

Please insert figure 1 here

2.3.2. Direct approach: questionnaire

Seven to ten days after the dish-composition task, participants were asked to complete an online self-reported questionnaire. To maintain a constant level of attention throughout the task, participants only evaluated sixteen of the images used in the dish-composition task (Figure 1). To obtain this set of 16 images, one product was excluded from each food group, on the basis of low consumption in France compared to other products in that food group (i.e. sausage, white beans, and gnocchi), while tomato was excluded from the Vegetable group as it may also be used for seasoning or sauce. Both the order of the food images and the order of the questions for each image were randomized.

2.4. Analysis

2.4.1. Indirect approach: Dish-composition task

The frequency with which each product was chosen by a participant for all of the scenarios was then converted into a rank. The product most frequently chosen by a participant obtained the highest rank. A Friedman test on the sum of ranks was used to determine if there were significant differences in product choice. A multiple pairwise comparison using the Nemenyi / Two-tailed test was then used to compare the frequency of choice of products in all scenarios.

The frequency of choice for pulses by each participant in each scenario was also converted into a rank as described above. A Friedman test was used to determine if the pulse chosen was different in relation to the scenario. A Nemenyi / Two-tailed test was performed to compare the choice of pulses across scenarios.

The two variables related to the intrinsic characteristics (age and sex) of the participants were used to construct a contingency table. A Correspondence Analysis (CA) with SPAD (version 5, Coheris, France) was used to visualize relationships between consumer profiles and product choices. The CA method is based on a test of independence between participant characteristics and product choice, according to a chi-square statistic.

2.4.2. Direct approach: questionnaire

For each item in the questionnaire, the answers given by each participant were ranked for each food. The product with the "lowest" score (left side of the scale) was given the lowest rank, while the product with the highest score (right side of the scale) obtained the highest rank. A Friedman test was performed on the sum of ranks and then a Nemenyi / Two-tailed test was used to compare the rank of each product for each question.

2.4.3. Complementarity between the two methods

Due to the difference in the nature of the data obtained by each method (frequencies for the dish-composition task, and ordinal data for the questionnaire), each dataset was converted into numerical format using the appropriate multivariate analysis. For the dish-composition task results, a Correspondence Analysis (CA) was carried out on the frequency of choice for each product in each scenario. The first three dimensions accounted for 96% of the total variance (respectively, 60, 28 and 8% for axes 1 to 3). In contrast, a Multiple Correspondence Analysis (MCA) was carried out on the questionnaire results. The first three dimensions accounted for 73% of the total variance (respectively 47, 16 and 10% for axes 1 to 3).

A Pearson Principal Component Analysis (PCA) was then performed, using the principal coordinates of the CA and the MCA as active variables. The first three dimensions were used as observations. The correlation matrix thus obtained made it possible to compare the results of the dish-composition task with those of the questionnaire (supplementary table).

The confidence interval was set at 95% for all the analyses. The XLSTAT for Windows (Addinsoft, version 2018-1) was used for both univariate and multivariate analyses.

Results

3.1. Dish-composition task

3.1.1. Reliability of the indirect method

Before going into detail about food-product choice, we looked at the choices made by participants during their very first dish-composition (by scenario), and after each of the five repetitions of the dish-composition task. The frequency of choice for each food group in each scenario, taking into account all the dishes created, is shown in Table 4. These results give an overview of repeatability across the five dishes within the same scenario, but also of the variability of food-product selection between scenarios. The results in Table 4 show that participants' choice of food groups was consistent for each of the successive repetitions of the dish-composition task.

Please insert table 4 here

3.1.1. Global frequency of choice for each food image

The frequency of choice for each food image is presented in Figure 2. The Friedman test showed significant differences across food products (p-value < 0.0001). Overall, the Vegetable group were the most frequently chosen (38%). In this group, the most frequently chosen product was tomatoes, followed by carrots, zucchini, green beans, and broccoli. The MFPE group represented 27% of choices: chicken was the most frequently chosen product, followed by beef, salmon, egg, and sausage. Within the Starch group (25% of choices), rice was the most frequently chosen product, followed by potato, tagliatelli, semolina, and gnocchi. The Pulse group, at only 10%, was chosen significantly less frequently for main-dish composition. Within the Pulse group, lentils were the most frequently chosen product, followed by red beans, red lentils, chickpeas, and white beans.

Please insert figure 2 here

3.1.2. Frequency of choices for pulses, in each scenario

As food products from the Pulse group were generally those least often chosen in the dish-composition task, it was important to see if the choice of pulses was the same in each scenario. Figure 3 shows that participants chose Pulse-group products differently for each scenario (p-value < 0.0001). Compared to the Everyday scenario (11%), considered as control, Pulse-group product frequency of choice was significantly higher in the Self-service (16%), Restaurant (23%), and Vegetarian (24%) scenarios. In the Vegetarian scenario, the range of possible choices was lower than in the other scenarios, with participants using only two of the five images from the MFPE group. In order to take this difference into account, the frequency of choice for each product was calculated on the basis of 17 possible choices, excluding those never used in the Vegetarian scenario (Table 4). Even after taking this correction into consideration, the choice of Pulse-group products was still more frequent in the Vegetarian scenario than in the Everyday scenario.

Please insert figure 3 here

3.1.3. Influence of participant characteristics on food-choice frequency for pulses

A Correspondence Analysis (CA) was used to study the associations between participant characteristics and food-product choices. Khi^2 test was significant (p-value<0.0001). Participants were separated into four groups, based on age and sex. The CA represented in Figure 4 shows how food-product choices vary between participants with different characteristics (age and sex). The distance between the points representing food products approximates the chi-square distance between food-product frequency of choice. Axis 1 represents 58% and axis 2 represents 27% of the total variance. Axis 1 distinguishes participants by age and axis 2 by sex; participants under 40 years of age used the images of red beans, chickpeas, and red lentils more often than older participants. In contrast, participants over 40 chose eggs and gnocchi more frequently than younger participants. Men favored MFPE products, especially red meat. Men over 40 chose sausage more often, while women over 40 tended to choose white beans and broccoli more often.

Please insert figure 4 here

3.2 Direct approach: online questionnaire

3.2.1. Scores given to the different food images

Table 5 shows a synthesis of the mean score for the sixteen food products, according to the ten evaluation criteria (question scripts). For each column, the highest score indicates the food most representative of that criterion: e.g. the fanciest, the most representative of men's food habits, the healthiest, the most well-liked, and the most frequently eaten. The results from the Friedman tests showed that there were significant differences across the products for all questions. Compared to other food groups, pulses were rated by participants as the food group most difficult to prepare, best adapted (along with the Vegetable group) for a vegetarian diet, and with the exception of lentils, the least frequently eaten and the least well liked.

If we look closer, participant ratings put pulses in second place, behind vegetables, as products that are relatively good for health and the environment, and behind MFPE products, but still quite rich in proteins. All pulses, except red lentils, were identified as being in the medium price range, neither ordinary nor fancy, and corresponding to a neutral food habit, rather than particularly feminine or masculine. Ratings for red lentils placed them just behind salmon, as the second most fancy product.

Please insert table 5 here

The MCA (Figure 5) reveals the modalities associated with each food product for each question. Axis 1 represents 47% of the total variance, with axis 2 representing 16%. Question scripts and response modalities are both clearly represented and well distributed. Axis 1 is characterized by food considered by participants as very expensive, and “very bad” for the health and for the environment. The products associated with these characteristics are from the MFPE group, which are opposed on this axis to plant products from the other three groups (Pulse, Vegetable, and Starch). The positive part of Axis 2 is characterized by food considered difficult to prepare, “not liked at all”, and “never consumed” by participants. All the pulses (except lentils, in a central position) are associated with these negative characteristics. Foods consumed “at least once a day”, but also considered very bad for the health are found on the negative part of axis 2. The products corresponding to these characteristics are mostly from the Starch group.

Please insert figure 5 here

3.3. Complementarity of the two approaches

The correlation matrix (Supplementary table) allows us to visualize the links between the results obtained by each of the two methods. Correlations coefficients greater than 0.997 are significant at α= 5%, and correlations coefficients greater than 0.988 are significant at α= 10%. Food choices in the Everyday scenario were significantly correlated with the consumption frequency declared in the online questionnaire for each food product. They were also correlated with “not adapted to a vegetarian diet”, “rich in proteins”, “not good” for either health or the environment, and corresponding to “very masculine food habits”. Products chosen in the Restaurant scenario were highly correlated with the “very expensive” and “difficult to prepare” modalities. Products chosen in the Guest scenario were significantly correlated with the “very expensive”, “corresponding to very masculine habits”, “not adapted for a vegetarian diet” and “not good for the environment” modalities. The products chosen in the Budget scenario were correlated with the characteristics “good for health [and] the environment”, and “poor in proteins”. They tended to be considered “very cheap”.

Food choices in the Vegetarian scenario were significantly not “very fancy”. In this scenario, consumers tended not to choose products that they considered “not adapted for a vegetarian diet” (coefficient correlation: -0.927), but there was, surprisingly, no significant correlation between the products chosen in the Vegetarian scenario and those considered to be “adapted for a vegetarian diet” (coefficient correlation: 0.668). Products chosen in the Vegetarian scenario also tended to be considered as not “rich in proteins”, not “very expensive” and not corresponding to “very masculine food habits”. In the Everyday scenario, consumed products were also declared as not adapted to a vegetarian diet in the questionnaire with a significant correlation coefficient of 0.998.

Discussion

One of the main objectives was to understand mental representations of pulses among French non-vegetarian consumers, and to identify potential barriers to pulse consumption. We therefore combined an indirect and a direct method, to determine the specific properties attached to pulses in the minds of consumers. We tried to understand how these properties could influence the consumption of pulses, and to propose levers to increase pulse consumption. Three main results will be discussed: the interest of combining these two methods, how mental representations of pulses can explain low pulse consumption, and why knowledge about pulses does not necessarily result in higher consumption. We then propose strategies to increase pulse consumption in France.

4.1. Interest of combining the two methods

To our knowledge, our study was the first to combine an innovative indirect approach with a more classical direct approach, in order to understand mental representations of pulses among French consumers. When it was possible, the same factors were studied by the two methods (consumption, difficulty to cook, product adapted for a vegetarian diet, perception of price). Depending on the parameter studied, the use of the two methods gave complementary or convergent information about consumers’ mental representations of pulses.

The two methods obtained similar results, with a high correlation coefficient between the results of the dish-composition task in the Everyday scenario and the declared consumption frequency in the questionnaire. This means that, in the dish-composition task, participants did not make random choices, and that their choices genuinely reflected their declared consumption habits. This is an argument in favor of the reliability of the dish-composition task, and of the use of the Everyday scenario as the control in our study.

In the Restaurant scenario, which was meant to evoke a no-cooking, prestigious context, participants tended to choose products that they considered difficult to prepare, and to exclude those they considered easy to prepare. This result was not found in other scenarios, indicating that this scenario is suitable for the study of participants’ mental representations of products they consider difficult to prepare.

These correspondences between the results of the two methods are a good indicator of the reliability of the dish-composition task with evoked scenarios (indirect method). This method was also shown to be repeatable within a given scenario, while producing different results for different scenarios. This exploratory study therefore provides a preliminary validation of the dish-composition task, which produced results comparable to those obtained with the questionnaire (direct method). Further studies will be necessary to confirm the reliability of the indirect method. In particular, reproducibility must still be confirmed, by studying several subsets of consumers from within a given population. This task may also be tested with different food products and new scenarios.

For other results, we did not find the expected correlations between the two methods. For example, the dish-composition task in the Budget scenario, meant to be an indicator of the price of products, was not significantly correlated with the declared price obtained through the questionnaire. Many studies have questioned whether consumers are reliable when asked about food price and its importance in choice. Price is often reminiscent of a purchase situation, which is usually complex. Consumers may take other factors into account when referring to the price of products. In particular, consumer attitudes toward price may be influenced by whether the price is judged acceptable or not, taking into account all available information about the product (Grunert, 2006). In our study, the products considered to be expensive were chosen in many scenarios, including the control scenario. Information about price seems to be accessible only for products considered to be cheap. Such products were chosen more often in the Budget scenario than in the control, and less often in the Restaurant scenario. Although products considered unsuitable for a vegetarian diet tended to be chosen less frequently in the Vegetarian scenario, somewhat surprisingly this scenario was not significantly correlated with products considered suitable for vegetarians. As the participants were not themselves vegetarian, we had to include another person in the scenario to create the need to choose food adapted for a vegetarian diet. Our explanation is the following: participants had some knowledge of vegetarian food products, but did not consider them to be fancy (significant correlation coefficient: 0.998), and thus perceived them to be unsuitable for an invited guest. Social norms tend to consider healthy foods less acceptable in social situations (Zorbas et al., 2018). Participants also used significantly more often in the Guest scenario products judged unsuitable for a vegetarian diet.

The absence of a clear relationship between the results of the two methods for these two examples can be seen as an advantage of the indirect method when accessing representations that are difficult to obtain accurately with direct questioning. The questionnaire provided access to consumer knowledge and beliefs about food, while the dish-composition task provided access to food habits and attitudes towards food. Questionnaire responses are more likely than the dish-composition task to suffer from social desirability bias. For the dish-composition task, participants were not asked to give structured answers; instead, they were asked to make choices visualizing themselves in different scenarios. Consumers were not required to focus their attention on a specific food item, allowing them to answer spontaneously, without speculating on the specific aim of the study. In the Everyday scenario, participants significantly chose products that are not good for health or for the environment, suggesting that social desirability was not a major concern. In contrast, when answering the questionnaire, participants were asked to focus their attention on specific products. By doing so, they may have been tempted to imagine what might be a "suitable" answer, or what answer was expected by the experimenters, and therefore to answer accordingly.

4.2. A low global consumption of pulses, evidenced by both methods

The choices observed when people are immerged in an evoked situation are thought to reflect the actual choices they would make in the corresponding real-life situation. The overall use of pulses during the dish-composition task was low, amounting to only 10% of all choices. Pulse images were by far the least chosen: these four images were among the six least used by participants. Thus, the dish-composition task indirectly revealed a low level of pulse consumption among participants, confirmed by the low self-declared consumption frequency of pulses, obtained from the questionnaire. The low consumption revealed by both tasks is in accordance with recent food consumption records in France, which highlighted a very low consumption of pulses (ANSES, 2017b). This shows that, based on pulse consumption, our participant sample is representative of French consumers in general. Our study thus allowed us to go further than consumption data, by accessing consumers' mental representations of pulses.

4.3. How representations of pulses can explain their low consumption

The factor that is the most highly correlated with declared non-consumption of food in our study was dislike. Hence, one of the most obvious reasons that can explain the low consumption of pulses is that they are declared to be least liked, with the exception of lentils, the pulse best appreciated by participants. A Canadian survey (IPSOS, 2010) highlighted that, when asking non-consumers to choose the relative importance of a number of factors regarding why they did not eat pulses, not liking the taste or texture of pulses emerged by far as the most important factor. Interestingly, in the same survey, taste was also the most frequent reason given for eating pulses by the group of "light, moderate, and heavy consumers". Several models are proposed in the literature listing the factors involved in food choices. Among these factors, taste is considered to be one of the main drivers of food choice and intake (Shepherd & Raats, 2006). In a study about the links between attitudes and beliefs toward various types of food, taste was shown to have the highest relationship with attitudes for most products (Shepherd & Towler, 1992). Yet the study also highlighted that perception of sensory attributes is not the only factor affecting food choices, despite its high impact on attitudes.

Another interpretation emerged from both methods used in our study. First, in the dish-composition task, participants chose pulses more often with the Restaurant and Self-service scenarios than with the Everyday scenario. The common point of these two scenarios suggests a situation in which participants do not have to prepare their meal themselves. This has to be put into perspective, using the responses to the questionnaire, which showed that participants considered pulses as the products most "difficult to cook". From this result, we can state that the difficulty of cooking pulses is one of the main obstacles to their consumption, as hypothesized by other authors (Lecerf, 2016; Rio, 2017). Because of this perceived difficulty, participants seem to avoid eating pulses when they have to prepare them themselves. Our results indicate a negative correlation between difficulty of preparation and consumption frequency, which can be considered as an obstacle to consumption in general. This result is consistent with the IPSOS-REID survey, which indicates that, along with taste, not knowing how to prepare or cook pulses is the second most frequent reason for not eating them (IPSOS, 2010). In our study, "difficult preparation" should be interpreted cautiously, because consumers may mean "technically difficult" and/or "difficult to plan for, in the context of daily duties". Preparing a pulse dish at home involves careful planning, to allow for the necessary soaking period, in addition to the time required for the cooking process. As lentils were the only pulses not considered "difficult to cook", the time required for soaking and cooking is probably the main reason why consumers seek to avoid preparing other pulses. It is widely recognized that there is an increasing demand for convenience in meal preparation, which allows consumers to save time and avoid wasting a lot of physical and mental energy (Scholderer & Grunert, 2005). In this context, at-home pulse preparation may represent too much time and effort, and thus be incompatible with the time already taken up by work, social life, and leisure activities.

Along with taste, price and healthiness are often proposed as important determinants of food choice. The argument of price as a driver in food choice is well-known in the literature and concerns many products (Darmon & Drewnowski, 2015). In our study, the role of price as a lever of consumption is not clear. The products rated most expensive were declared to be consumed the most, and used the most in the dish-composition task in the Everyday scenario. But there was no correlation between declared price and the food chosen in the Budget scenario. It has been shown that perceived price does not involve the price of the product alone. Attitude towards price is influenced by the relationship between the objective price of the product and some reference price postulated by consumers (Grunert, 2006; Ritson & Petrovici, 2001). This reference price is integrated with other product information when forming attitudes towards purchase (Grunert, 2006). The influence of price may be heterogeneous between food categories, because other characteristics specific to a food type may come first (e.g. safety for meat, and brand for chocolate, according to Ritson and Petrovici, 2001).

Our results also showed that pulses were more often used in the Vegetarian scenario than in the other scenarios. From a methodological point of view, the Vegetarian scenario was deliberately not defined, so that participants could interpret this scenario according to their representations of what a vegetarian diet may be. Consumers tend to use a unique word ("vegetarian") when referring to different types of diets excluding meat and poultry. These diets include the vegan diet (no animal products at all), the lacto-ovo-vegetarian diet (including dairy products and eggs), and the pesco-vegetarian diet (including fish, eggs, and dairy products) (Tonstad, Butler, Yan, & Fraser, 2009). In our study, participants placed in a vegetarian context could thus be expected to exclude beef, chicken, and sausage but might still select salmon and eggs from the MFPE group, depending on their definition of a vegetarian diet. Thus, in the Vegetarian scenario, participants could choose food products either among the four groups (selected egg and salmon from the MFPE group), or only among the three plant-based food groups, or among fewer groups, by choosing two or three products from the same food group. In this scenario, choice of products from the MFPE group was divided by four compared to the Everyday scenario. After correcting the results of the Vegetarian scenario to take into account the total number of products chosen in this scenario, the increase in Pulse choice appears to be the highest compared to other plant products. Pulse choice after correction was multiplied by 1.8 compared to the Everyday scenario, while Starch products were not more frequently chosen and Vegetable products were only multiplied by 1.1. This is consistent with Pulse and Vegetable group products being rated in the questionnaire as the foods best adapted for a vegetarian diet. The congruence between the results of the two methods for Pulse group products indicates that consumers considered pulses as products for vegetarians. This result is coherent with a study in Finland, which identified an association between beans and vegetarianism (Jallinoja et al., 2016). A similar result was also obtained from a Canadian survey (IPSOS, 2010). Pulses may be selected by vegetarian consumers who know the importance of their high protein, fiber, and micronutrient content. This frequent consumption by vegetarians seems to be known by non-vegetarians, who tend to associate pulses with a vegetarian diet. This mental representation of pulses as a "niche product" for vegetarians could represent a barrier to consumption by non-vegetarian consumers, since frequently consumed products were declared as not adapted to a vegetarian diet in the questionnaire.

4.4. Knowledge about pulses does not necessarily result in higher consumption

Some studies have found that one of the main barriers for not adopting a plant-based diet is the lack of information (Lea, Crawford, & Worsley, 2006; Poquet, Chambaron-Ginhac, Issanchou, & Monnery-Patris, 2017). Adequate knowledge is therefore regarded as a necessary - though not sufficient - requirement for healthy sustainable food choices (Frick, 2018). In our study, questionnaire results highlighted that pulses were considered as more eco-friendly and healthy products than all the MFPE products, but less so than vegetables. In addition, pulses were evaluated as products with a relatively high protein content, just below all the foods of animal origin. This suggests that our participants have relevant knowledge about pulses; they know about their protein content, and their benefits for health and the environment. Yet it seems that this knowledge was not used during the dish-composition task, or that it may have been accessed, but that taste preferences, habits, and other characteristics were considered to be more important.

The literature on nutrition knowledge and food choice is contradictory. Some researchers have shown that nutrition knowledge is positively correlated with making healthy food choices, while other researchers highlight a very weak relationship between nutrition knowledge and food choice. One study mentioned that much of the literature fails to clarify the influence of specific aspects of nutrition knowledge on relevant dietary outcomes (Spronk, Kullen, Burdon, & O'Connor, 2014). Merely having nutritional knowledge may not be sufficient to modify food choices. One example in France is the Programme National Nutrition Santé (PNNS), which explicitly formulates simple health recommendations for consumers "Pour votre santé, ne mangez pas trop gras, trop salé, trop sucré" (For your health, do not eat foods that are too fatty, too salty, or too sweet), yet consumer food choices are not always optimal (Chambaron, Chisin, Chabanet, Issanchou, & Brand, 2015).

4.5. Perspectives: how to include more pulses in French food habits

As knowledge about the benefits of pulses seems to be insufficient to encourage their consumption, there is a need to find other levers, not based on communication about their protein content and their interest for health and the environment. Our study allowed us to identify such levers.

Out-of-home meals could provide an opportunity to increase daily consumption of pulses in France. We have shown in our study that the Restaurant and Self-service scenarios increase the frequency of pulses being chosen. These two scenarios reflect an authentic food habit among French consumers, with 44% of lunches consumed outside the home for adults aged 18 to 44, compared to only 28% for adults aged 45 to 64 (ANSES, 2017a). More recipes with pulses could be proposed in cafeterias and restaurants, giving consumers the opportunity to get to know or rediscover pulses. By encountering the taste of pulses more often, consumers could come to appreciate them more and more, become more familiar with them, and curious about preparing pulse-based dishes for themselves. It will be necessary to help people to acquire knowledge of how to cook pulses properly, by proposing new recipes with different levels of difficulty, stating the time needed, and taking into consideration the different types of consumers and the type of foods they like.

In our study, participants used pulses similarly in the Guest scenario and the Everyday scenario, which indicates that they do not exclude pulses from a situation of social interaction. This means that pulses do not necessarily have a bad reputation among participants. In all scenarios, younger participants chose red beans, chickpeas and red lentils more frequently, which suggests a "young" product image for these particular pulses, probably linked to the fact that they are imported from other food cultures. Questionnaire results indicate that participants considered red lentils to be more fancy than other pulses, and fancier even than beef. All these results indicate that certain pulses can benefit from a positive image. One strategy to increase consumption could thus be to capitalize on this image in order to create innovative foods targeting specific consumers. For example, new products could be created in small formats, like snacks or ready-to-eat dishes, to encourage red bean and chickpea consumption, for young consumers. These products could be inspired by other cultures, with a variety of recipes containing pulses, from Mexico (red beans) or India (chickpeas). To increase the attractiveness of these new products, it is necessary to work not only on their organoleptic properties, but also to take into account their extrinsic properties to attract young consumers' interest. For example, communication should focus on national brands, local and seasonal products, and use the internet and social media, rather than broadcasting on television / radio (ANSES, 2017a).

One final strategy that can be proposed, based on the results of our study, is not to present pulses as a food for vegetarians only. It is necessary to overcome the perceived gap between non-vegetarians and vegetarians, and to encourage all consumers to increase pulse consumption. The main barrier to this shift is probably that non-vegetarians feel that they lack information on how to compose meals around pulses if they do not refer to a traditional recipe. In France, traditional recipes involving pulses usually contain meat (Rio, 2017). It would therefore be interesting to study how French people associate pulses with other food products. Do they use pulses as a substitute for starches, since French recommendations classified them in the same group for many years? Do they use pulses as a substitute for vegetables, due to their commonly perceived healthiness, as evidenced in our study? Do they use pulses as a substitute for meat, due to their acknowledged high protein content? Answering these questions would give us more information regarding the place that pulses have in French food habits, and thus help us to develop new strategies.

4.6. Strengths and limitations

One of the strengths of our study was the use of two distinct, yet complementary methods to identify consumer representations that explained low pulse consumption. Some of the properties attributed to pulses by consumers were detected by both methods, suggesting that they are strong barriers to consumption. The price factor was tested by both approaches, but only the indirect approach revealed a link between this factor and low consumption. Such a result could reflect potential involvement of implicit attitudes, which have been shown to predict actual behaviors (Marty et al., 2017). More research will be necessary to confirm the importance of the barriers identified by the indirect method in our study. Other indirect approaches or implicit methods could be used to test the impact of these factors on pulse choice and consumption.

One of the main limitations to our study is that consumer behavior is not measured in real-life conditions. It is possible that food products chosen in an evoked context might not systematically be chosen in real life. Further studies will be necessary to ensure that scenarios provide a level of immersion sufficient for participants to react as they would in an authentic real-life situation. Another limitation relates to the questionnaire, which contained ten questions for each image. Only sixteen of the twenty food products were therefore presented online, so that participants could maintain an adequate level of attention throughout the task.

Conclusion

By combining an indirect method (a dish-composition task with an evoked situation) with a direct method (an online questionnaire), we identified several reasons to explain the low consumption of pulses in France. Our findings provide new evidence of potential barriers to pulse consumption, linked to taste, perceived difficulty of (lengthy) preparation, and the persistent image of pulses as a food clearly associated with a vegetarian diet.

Participants possessed theoretical knowledge about pulses: they were aware of their environmental and health benefits, as well as their high protein content. Yet this awareness did not lead them to modify their food behavior by increasing their consumption of pulses. Our results showed that participants lacked practical knowledge of pulses. More information is necessary about how to cook pulses, how to associate them with other ingredients to create pulse-based dishes, and on what occasions it is appropriate to serve pulses.

To date, communication campaigns in France have simply told consumers to increase their consumption of pulses. Our study identifies other strategies that could prove effective: familiarity can be increased by focusing on out-of-home meals; trendy innovative products can be developed to fit consumer profiles; communication campaigns clearly presenting pulses as a “food for all” can modify erroneous and limited mental representations. Consumers may thus be encouraged to choose pulses more frequently in their everyday lives, with the resulting benefits for their health and for the environment.

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Figure 1.

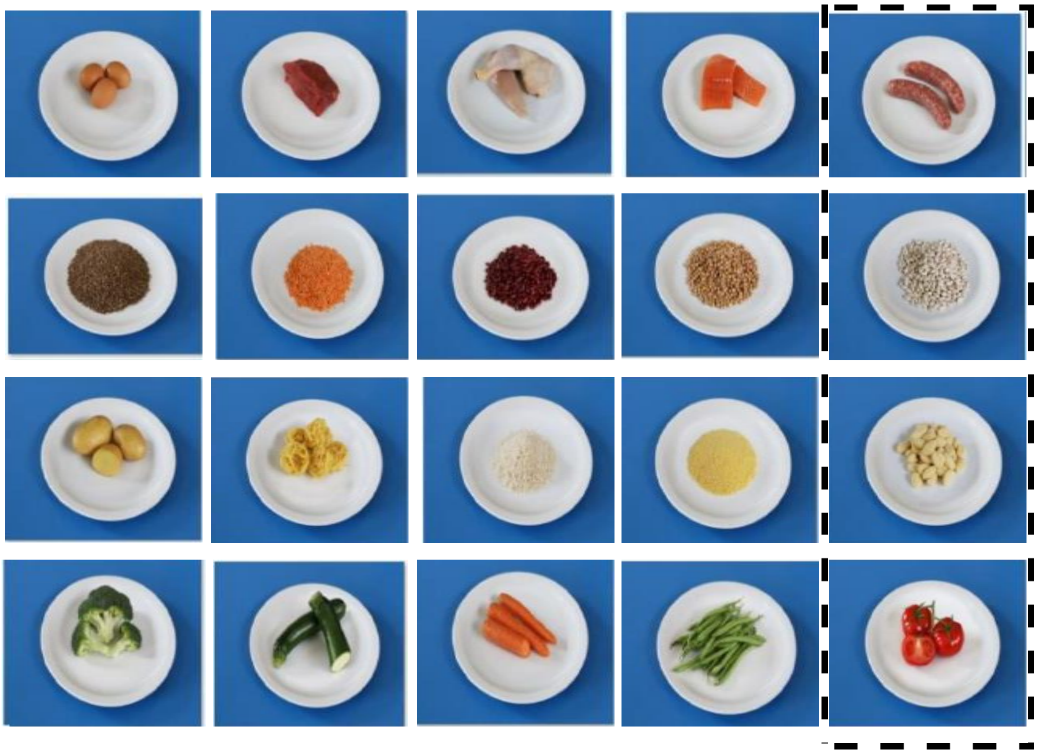
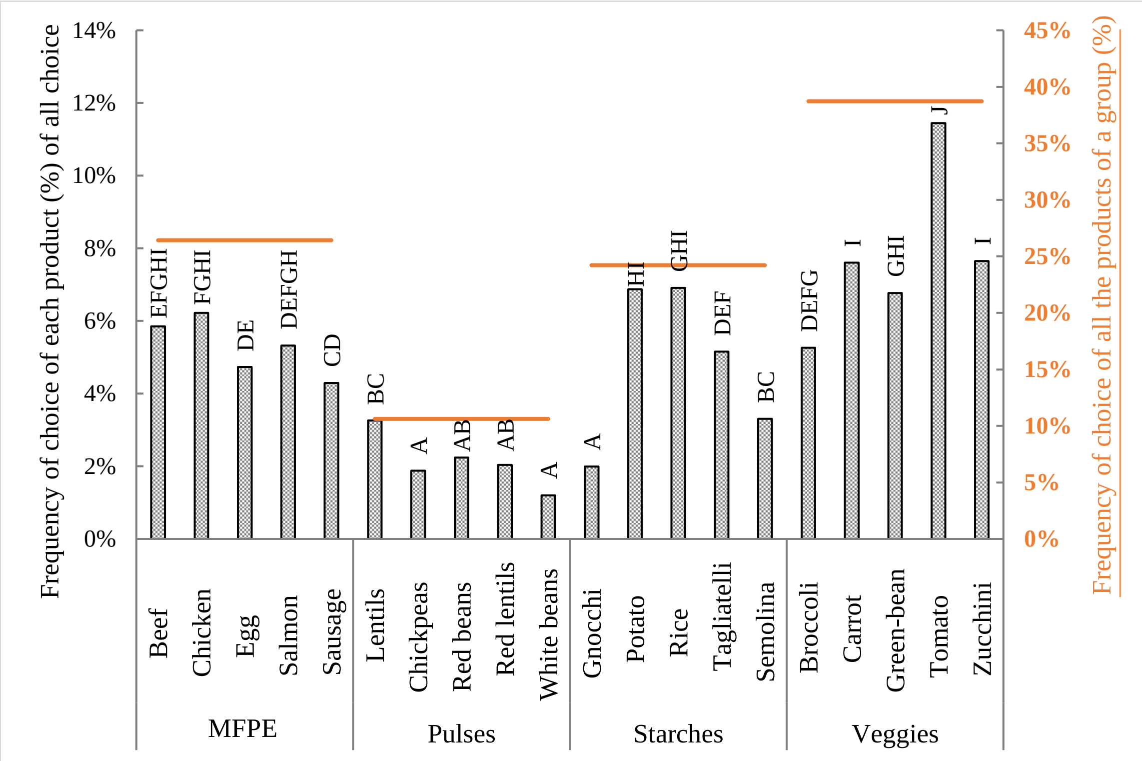


Figure 2



Frequency of choice of each product (%) of all choice
14%
12%
10%
8%
6%
4%
2%
0%
EFGHI
FGHI
DE
DEFGH
CD
BC
A
AB
AB
A
A
HI
GHI
DEF
BC
DEFG
I
GHI
J
I
Beef
Chicken
Egg
Salmon
Sausage
Lentils
Chickpeas
Red beans
Red lentils
White beans
Gnocchi
Potato
Rice
Tagliatelli
Semolina
Broccoli
Carrot
Green-bean
Tomato
Zucchini
MFPE
Pulses
Starches
Veggies
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Frequency of choice of all the products of a group (%)

Figure 3

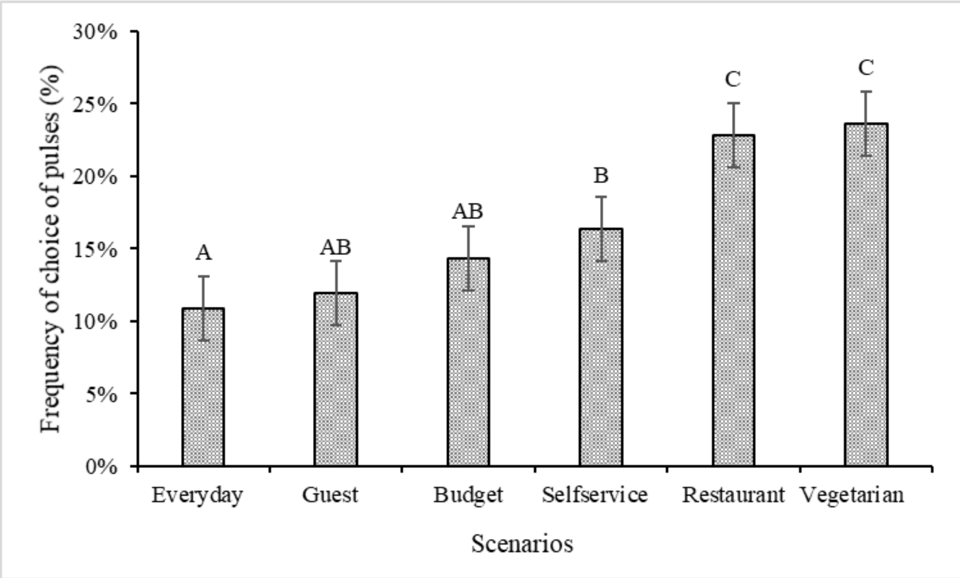
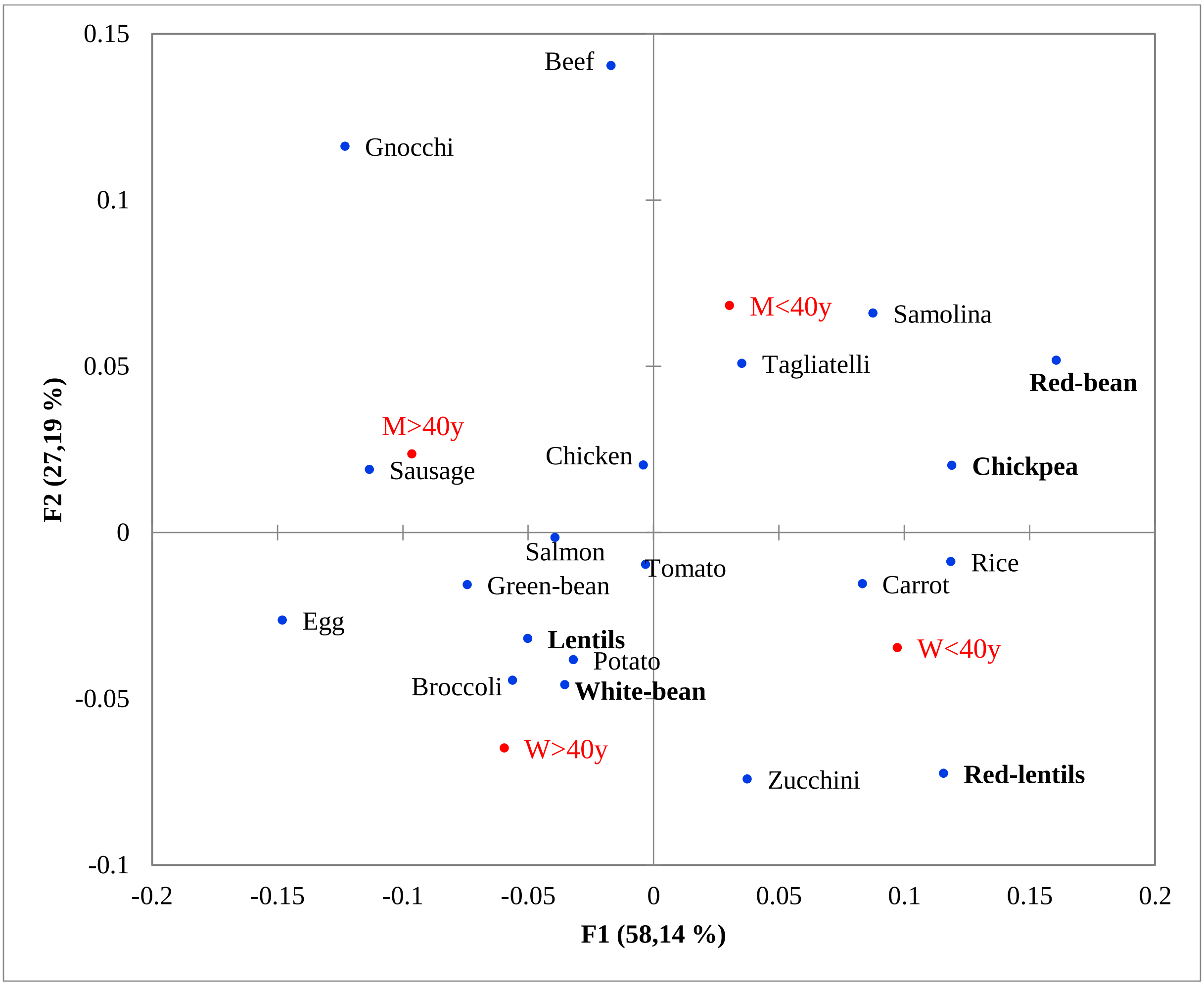
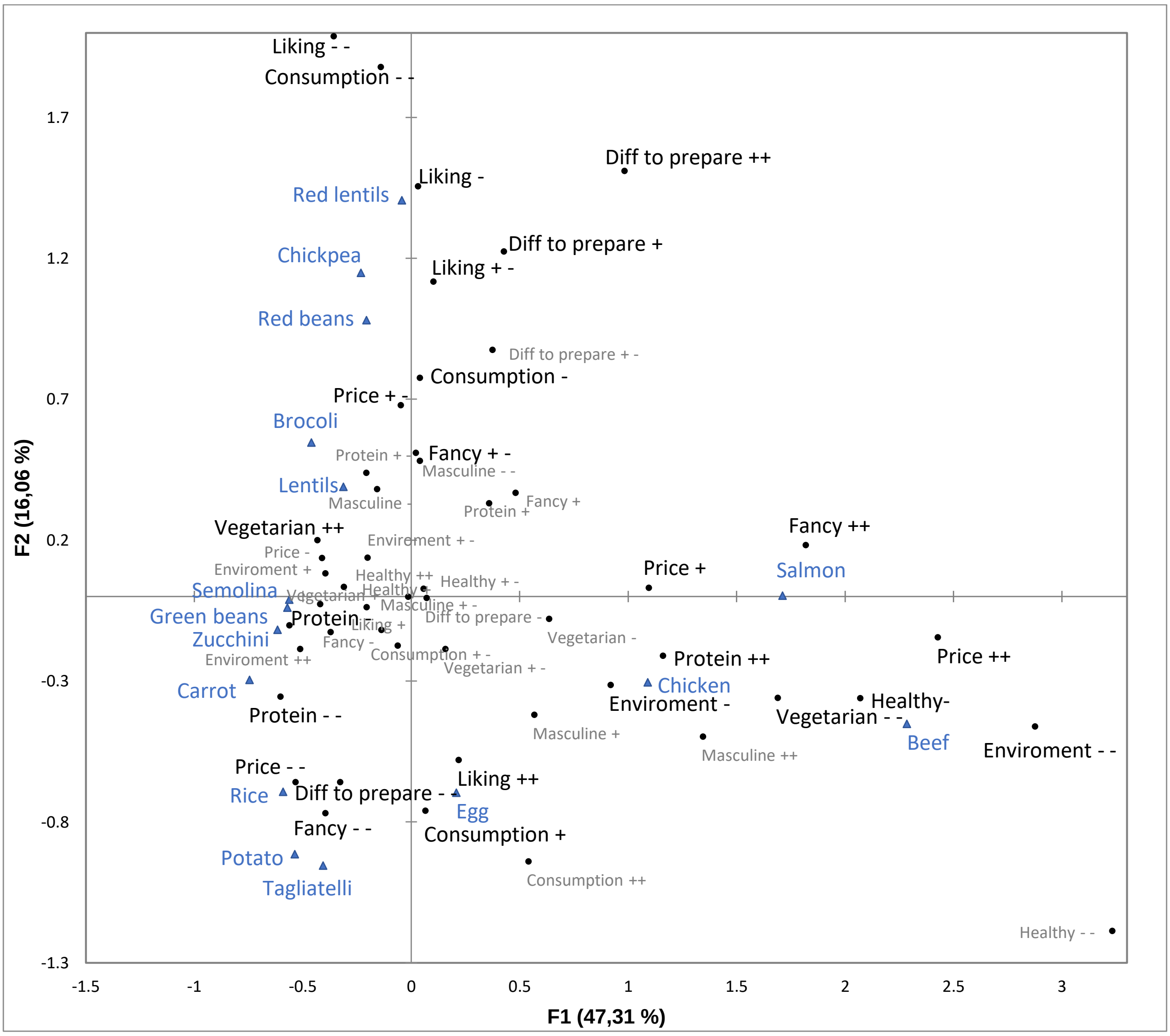

30%
25%
20%
15%
10%
5%
0%
Frequency of choice of pulses (%)
A
AB
AB
B
C
C
Everyday
Guest
Budget
Selfservice
Restaurant
Vegetarian
Scenarios

Figure 4



0.15
0.1
0.05
0
-0.05
-0.1
F2 (27,19 %)
-0.2
-0.15
-0.1
-0.05
0
0.05
0.1
0.15
0.2
F1 (58,14 %)
Beef
Gnocchi
M<40y
Samolina
Tagliatelli
Red-bean
M>40y
Chicken
Sausage
Chickpea
Salmon
Tomato
Rice
Green-bean
Carrot
Egg
Lentils
W<40y
Potato
Broccoli
White-bean
W>40y
Zucchini
Red-lentils

Figure 5



Liking - -
Consumption - -
Diff to prepare ++
Liking -
Red lentils
Chickpea
Diff to prepare +
Liking + -
Red beans
Diff to prepare + -
Consumption -
Price + -
Brocoli
Protein + -
Fancy + -
Masculine - -
Lentils
Masculine -
Protein +
Fancy +
Vegetarian ++
Fancy ++
Price -
Enviroment + -
Enviroment +
Healthy ++
Healthy + -
Price +
Salmon
Semolina
Vegetarian +
Healthy +
Masculine + -
Green beans
Protein -
Liking +
Diff to prepare -
Zucchini
Fancy -
Vegetarian -
Enviroment ++
Consumption + -
Vegetarian + -
Protein ++
Price ++
Carrot
Chicken
Enviroment -
Healthy-
Protein - -
Vegetarian - -
Masculine +
Beef
Masculine ++
Enviroment - -
Price - -
Liking ++
Rice
Diff to prepare - -
Egg
Fancy - -
Consumption +
Potato
Tagliatelli
Consumption ++
Healthy - -
1.7
1.2
0.7
0.2
-0.3
-0.8
-1.3
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
3
F2 (16,06 %)
F1 (47,31 %)

Table 1

Characteristics	Categories	Number of participants	%
Sex	Male	60	50
	Female	60	50
Age	<40 years	66	55
	>40 years	54	45
Education level	High	41	34
	Medium	40	33
	Low	39	33
Household composition	Family	33	28
	Couple	47	39
	Living alone	40	33

Table 2

Title of the scenario*	Script*
Everyday "as control"	In an everyday meal at your home, you have to prepare the meal.
Self-service	You decide to eat at the self-service cafeteria. All the foods represented in the images are on the menu.
Restaurant	You won a dinner at a four-star restaurant during a competition. The restaurant concept invites you to create a dish from a list of ingredients, in order to test the chef's talents.
Budget	At the end of the month, after you paid most of your bills, you do not have a lot of money left and you have to prepare a cheap meal
Vegetarian	You invited a friend for a meal, which you have to prepare. You have to remember that your friend is vegetarian.
Guest	You and your partner decided to invite the couple who just moved in next door for a meal at your place.

** Participants were given only the text of the scenario (Script, without Title). The "Title" was created merely to identify scenarios in this paper.*

Table 3

Question scripts	Response modalities on a 5-point ordered category scale
Rate each food according to its level of ordinariness or fanciness	From “very ordinary” to “very fancy”
Taking into consideration your habits, rate each food according to difficulty of preparation	From “easy” to “difficult”
Rate each food according to its price (Consider the presentation you consume most often)	From “not expensive” to “very expensive”
Rate each food according to masculine or feminine food habits	Rating from “very feminine” to “very masculine”
Rate each food according to its suitability for a vegetarian diet	From “not at all adapted” to “very well-adapted”
Rate each food according to its effect on health	From “very bad” to “very good”
Rate each food according to your food preferences	From “I do not like it at all” to “I like it very much”
Rate each food according to its impact on the environment	From “very bad” to “very good”
Rate each food according to its protein content	From “poor in proteins” to “rich in proteins”
Rate each food according to your frequency of consumption	From “never” to “at least once a day”

Table 4

Scenario		Dish 1	Dish 2	Dish 3	Dish 4	Dish 5	Total Scenario
All 20 images taken into account							
Everyday	MFPE	30%	30%	30%	28%	30%	30%
	Pulses	6%	6%	6%	11%	7%	7%
	Starches	25%	26%	23%	23%	24%	25%
	Veggies	39%	39%	41%	38%	38%	39%
Self-service	MFPE	32%	31%	32%	31%	30%	31%
	Pulses	8%	7%	11%	13%	14%	10%
	Starches	27%	26%	23%	23%	21%	24%
	Veggies	33%	35%	34%	33%	35%	34%
Restaurant	MFPE	34%	34%	34%	32%	29%	33%
	Pulses	18%	14%	12%	15%	14%	15%
	Starches	16%	20%	21%	20%	20%	19%
	Veggies	33%	32%	33%	33%	38%	34%
Guest	MFPE	35%	31%	33%	33%	31%	33%
	Pulses	4%	8%	9%	9%	8%	8%
	Starches	29%	24%	23%	21%	22%	24%
	Veggies	32%	36%	36%	37%	39%	36%
Budget	MFPE	26%	25%	25%	23%	23%	24%
	Pulses	8%	10%	8%	8%	13%	9%
	Starches	31%	28%	27%	27%	27%	28%
	Veggies	36%	37%	41%	42%	38%	39%
Vegetarian	MFPE	9%	8%	7%	9%	7%	8%
	Pulses	12%	18%	17%	14%	14%	15%
	Starches	25%	23%	25%	29%	28%	26%
	Veggies	54%	52%	51%	47%	51%	51%
Only 17 images taken into account, excluding those not used in the vegetarian scenario*							
Vegetarian	MFPE	8%	7%	6%	8%	6%	7%
	Pulses	10%	15%	14%	12%	12%	13%
	Starches	21%	20%	21%	25%	24%	22%
	Veggies	46%	44%	43%	40%	43%	43%

** Beef, sausage, and chicken were never selected in the vegetarian scenario.*

Table 5

	Product	Fancy	Difficult to prepare	Expensive	For men	For vegetarians	Healthy	Food preference	Eco-friendly	High protein	Consumption
MFPE	Beef	12.03 ^{ab}	10.50 ^{ab}	15.18 ^{a}	13.87 ^{a}	1.95 ^{e}	4.85 ^{g}	8.99 ^{abcd}	3.59 ^{e}	13.55 ^{a}	10.81 ^{ab}
	Chicken	8.43 ^{de}	8.96 ^{bc}	9.62 ^{b}	4.57 ^{cde}	10.88 ^{e}	11.81 ^{defg}	7.63 ^{abcd}	10.74 ^{e}	5.20 ^{a}	6.61 ^{ab}
	Egg	6.16 ^{fg}	7.23 ^{def}	5.90 ^{efg}	5.87 ^{bcd}	10.84 ^{d}	11.59 ^{cdef}	8.95 ^{abcd}	10.89 ^{d}	4.88 ^{ab}	10.26 ^{a}
	Salmon	13.98 ^{a}	8.60 ^{ab}	11.83 ^{a}	9.50 ^{fg}	1.99 ^{e}	6.64 ^{bcd}	9.50 a	4.62 ^{e}	12.67 ^{a}	10.62 ^{cd}
Pulses	Chickpeas	8.79 ^{cd}	12.00 ^{a}	7.74 ^{def}	9.28 ^{cde}	10.59 ^{ab}	8.03 ^{cde}	5.15 ^{f}	9.50 ^{abc}	9.96 ^{c}	3.63 ^{g}
	Lentils	7.93 ^{def}	5.74 ^{ab}	7.22 ^{def}	10.51 ^{ef}	5.94 ^{a}	7.57 ^{ab}	9.41 ^{bcd}	6.89 ^{ab}	13.22 ^{bc}	11.60 ^{de}
	Red beans	9.03 ^{cd}	7.87 ^{a}	9.00 ^{cde}	5.84 ^{bcde}	11.08 ^{ab}	11.87 ^{cdef}	9.35 ^{ef}	11.13 ^{abc}	5.07 ^{c}	9.32 ^{fg}
	Red lentils	12.24 ^{ab}	10.26 ^{a}	7.59 ^{bc}	7.97 ^{g}	11.13 ^{ab}	10.57 ^{bc}	8.45 ^{ef}	9.99 ^{abc}	10.79 ^{c}	6.63 ^{g}
Starches	Potato	4.64 ^{g}	5.72 ^{ef}	4.83 ^{h}	11.73 ^{b}	9.49 ^{abc}	6.60 ^{defg}	9.98 ^{ab}	10.15 ^{ab}	5.86 ^{d}	11.29 ^{ab}
	Rice	5.76 ^{g}	11.48 ^{ef}	8.31 ^{gh}	10.01 ^{bcde}	10.44 ^{abc}	7.73 ^{cdef}	6.03 ^{abcd}	9.56 ^{bcd}	9.63 ^{d}	4.31 ^{ab}
	Semolina	6.61 ^{efg}	11.43 ^{c}	10.33 ^{gh}	5.56 ^{de}	10.68 ^{bc}	9.28 ^{efg}	5.77 ^{cde}	9.45 ^{bcd}	9.90 ^{d}	3.20 ^{ef}
	Tagliatelli	5.51 ^{g}	5.41 ^{f}	5.12 ^{h}	9.79 ^{bc}	9.48 ^{c}	7.35 ^{fg}	8.91 ^{abc}	8.45 ^{cd}	5.71 ^{d}	10.92 ^{a}
Veggies	Broccoli	10.60 ^{bc}	10.70 ^{bc}	15.16 ^{cd}	6.38 ^{g}	3.80 ^{ab}	8.53 ^{a}	10.84 ^{de}	4.48 ^{a}	13.23 ^{d}	8.17 ^{de}
	Carrots	6.58 ^{efg}	8.03 ^{cde}	5.34 ^{fgh}	8.78 ^{fg}	8.85 ^{ab}	5.98 ^{a}	7.77 ^{abcd}	8.17 ^{a}	5.90 ^{d}	6.02 ^{abc}
	Green beans	8.82 ^{cd}	4.86 ^{cd}	4.57 ^{cde}	11.06 ^{g}	8.19 ^{a}	5.65 ^{a}	9.87 ^{abcd}	7.44 ^{a}	6.15 ^{d}	11.93 ^{bc}
	Zucchini	8.89 ^{cd}	7.22 ^{cde}	8.28 ^{cde}	5.28 ^{g}	10.68 ^{ab}	11.97 ^{a}	9.42 ^{abcd}	10.98 ^{a}	4.28 ^{d}	10.67 ^{ab}

For each question, products with the same letter were chosen with comparable frequency (Nemenyi / two-tailed test;p<0.05)