Importance of additional information, as a complement to information coming from packaging, to promote meat substitutes: A case study on a sausage based on vegetable proteins

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Abstract:

Scientific literature has shown that a partial replacement of meat-based foods with plant-based foods would be beneficial for public health and the environment. However, both lack of sensory attractiveness and lack of consumer awareness regarding benefits of rebalancing diets in favor of plant protein partially explain the low market shares for meat alternatives. In the context of a possible substitution of a meat product (pork-based sausage) by a visually very close counterpart based on vegetable proteins, the objective of this work was to study the possibility of changing consumer preferences towards the plant-based product by gradually providing information concerning the health or environmental consequences of consuming both types of products. We studied consumers' preferences after a blind tasting, after a tasting in the presence of the packaging, and after the dissemination of two stages of information. The assessment of consumer preferences was carried out using purchase preferences (PP) and willingness to pay (WTP). After the blind tasting, PP were clearly oriented towards the meat product. After the tasting with packaging information, the gap between the two products narrowed, but PP were still turned towards the meat product. The dissemination of a first informative message about either health or the environment was not enough to modify consumers' WTP. Adding a second message concerning health led to an equivalence of the two products studied in terms of WTP and PP. The combination of the two environmentally informative messages also made it possible to obtain an equivalence of the WTP for both products, but the PP were still turned towards the pork product. This suggests that the impact of additional information depends on the information disseminated. Overall, these results militate in favor of the dissemination of information presenting the consequences of the consumption of meat-based or vegetable protein-based products.

Keywords: Willingness to pay; purchase preference; meat substitute; information; taste

1. Introduction

The production of meat and animal-based products is associated with a significant negative impact on the environment (Hedenus et al., 2014, MacDiarmid et al., 2016). Indeed, greenhouse gas emissions from the agriculture sector account for approximately 22% of global total emissions, and livestock production accounts for nearly 80% of this specific sector's emissions (McMichael et al. 2007). Moreover, excessive consumption of red meat, particularly processed meat, is associated with an increased risk of total mortality, cardiovascular disease, colorectal cancer and type 2 diabetes in both men and women (Micha et al., 2010, McAfee et al., 2010, Richi et al., 2015).

A partial replacement of meat-based foods with plant-based foods is of dual interest. On the one hand, changing the diet of animal-based foods to plant-based foods would reduce greenhouse gas emissions and could therefore be more environmentally sustainable (Heller et al, 2013, Tilman and Clark, 2014, Auestad and Fulgoni, 2015, GBD 2017 Diet Collaborators, 2017). On the other hand, moderation of consumption of red meat and meat products, except for a specific population such as the elderly, would be beneficial in terms of public health (Ricci et al., 2015, Willet et al, 2019).

One way to reduce the consumption of meat-based foods is to replace them with plant-based alternatives. This strategy has the advantage of not radically changing dietary habits. The meat is simply replaced by a product that mimics the sensory properties of meat (Siegrist and Hartmann, 2019). However, there is a general unwillingness to reduce meat consumption or substitute meat for other foods among the vast majority of consumers, at least in various European countries (Hartmann & Siegrist, 2017). The main barriers to this substitution are product novelty, the lower sensory attractiveness of the substitutes compared to meat, and price (Hoek et al., 2011, Schösler et al., 2012, Weinrich and Elshiewy, 2019). In addition, many consumers are unaware of the environmental impacts of meat consumption and of the beneficial consequences of an overall reduction in the consumption of meat and meat products. (Austgulen et al., 2018, Lacroix et al., 2019). Indeed, one of the main conclusions of Hartmann and Siegrist's systematic literature review (2017) is that consumer awareness of the environmental impact of meat production is surprisingly low (European countries). Habits and beliefs regarding the positive health effects of meat could also prevent some consumers from transitioning to lower meat consumption (Hartmann and Siegrist, 2020).

The most effective way to promote the transition to meat substitutes is probably to improve their sensory attractiveness (Hoek et al., 2011, Slade, 2018). The perception of taste and appearance are indeed one of the main obstacles to the consumption of meat substitutes (Weinrich, 2019). However, major efforts in terms of research and development have already been made to propose substitutes as similar as possible to their meat counterparts. For example, wheat and pea are two

plant species that are widely consumed and whose proteins can be used to produce processed products that mimic meat-based sausages. These products are already available to consumers, and it may be possible to promote their consumption by providing information and increasing awareness of health and environmental benefits.

The overall objective of this study was to show that, in the context of substitution between a meat-based product (pork sausage) and a vegetable protein-based counterpart (plant-based sausage), an information concerning the consequences on health or the environment could be useful for promoting the plant-based products. More specifically, the objective was to study the preferences of consumers for these two products, according to taste, taste and packaging, and finally after the dissemination of informative messages concerning the consequences for health or the environment linked to the production and consumption of these two types of products. This information would make it possible to know whether the information carried by the packaging is sufficient to promote the herbal product and whether additional information concerning health or the environment would allow additional promotion. The conclusions of this study could provide leads concerning possible levers of action to promote a rebalancing of the origin of proteins in diets. We believe that our objective addresses current concerns regarding food, health and the environment. In a recent review of the literature, Weinrich (2019) suggests that more studies should be carried out combining information treatment, purchase motivations and the calculation of WTP for meat.

2. Materials and methods

2.1. Method

To achieve our objective, we have determined consumers' purchase preferences (PP) for both sausages, first according to "taste" (blind tasting), then according to taste and packaging and finally according to taste, packaging and a series of information about nutritional or environmental consequences of consuming foods based on animal or plant proteins. The PP collected after a blind tasting made it possible to evaluate consumers' preferences according to taste. Our hypothesis was that the PP collected for the meat product would be higher than plant-based substitute (hypothesis 1), as often the case. The PP collected after a second tasting of the products in the presence of their packaging makes it possible to assess consumer preferences in a context close to real consumption conditions, that is by knowing the information carried by the packaging (first level of information). Our hypothesis was that the comparison of the information carried by the two packages would allow a first rebalancing of preferences, in favor of the plant-based product (hypothesis 2). Finally, the PP collected after a series of additional information was intended to estimate the potential effect of an

increase in the level of information concerning certain advantages and disadvantages linked to the production and consumption of the two types of product. Our hypothesis was that consumers (at least part of them) would be sensitive to the information and that the additional information would allow a second rebalancing of PP of the two products, in favor of the plant-based product (hypothesis 3). Indeed, according to Weinrich (2019), providing information on the benefits of meat substitutes can influence consumer acceptance. Weinrich (2019) also specified that positive persuasion drivers involve, among other things, arguments on health and environment.

Additionally, on three occasions, we collected the consumers' willingness to pay (WTP) for both sausages, first after tasting in the presence of the packaging (i), then after a first (ii) and second (iii) message concerning certain advantages and disadvantages linked to the production and consumption of the two types of product. WTP is another method of understanding consumer preferences from an economic perspective. The bonuses or penalties awarded by consumers reflect the relative importance given to the various pieces of information given in this study. In particular, the difference between the WTP given after tasting with the packaging and the WTP given after the first informative message allows us to know more about the importance that given by consumers for the information disseminated in this first message. Similarly, the WTP collected after the second message makes it possible to deduce the effect of a further reinforcement of the information. Our hypothesis was that the results obtained with WTP would be consistent with the results obtained with PP, that is, that the initial WTP (tasting in the presence of the packaging) would be higher for the meat product, and that the informative messages would gradually rebalance the WTP for the two products (hypothesis 4).

The validation of hypothesis 1 would make it possible to verify that we have placed ourselves in a favorable case for this study, that is, in the case where a plant-based substitute is less appreciated than the reference product at the meat base. The validation of the other hypotheses would make it possible to demonstrate the usefulness of additional information, in addition to the information carried by packaging, in rebalancing consumer preferences in favor of the meat-based substitute. Similar approaches have been used in several previous works (Lange et al. 2002, Combris et al., 2006, Roosen et al., 2007, Ginon et al., 2009, Teuber et al., 2016) on different products (Champagne, fish and bread), to study the impact of different information provided to consumers (brand, omega-3 fatty acids, methylmercury, bio, fiber and anthocyanins).

2.2. Experimental conditions

The experiment was conducted in March 2019 in a tasting room at the INRAE (National Research Institute for Agriculture, Food and Environment, center of Dijon, France) that could accommodate 16

people simultaneously. Each participant was seated in an individual cabin equipped with data collection software. All participants received an informative note describing the conditions for participation in the study and signed a consent form. Each participant received 10 € indemnity for his or her participation in a session lasting approximately 1 hour.

2.3. Participants

A sample of 122 regular consumers of pork (including occasional consumers) living in the agglomeration of Dijon (France) was selected for this experiment. The statistics presented below were based on the 102 participants for whom we obtained complete data. For the purposes of the study, these 102 subjects were randomly divided into two groups. The Health group (n = 52) received information regarding the health benefits of partially substituting meat-based foods for plant-based foods. The Environment group (n = 50) received information regarding the environmental interest of such a substitution (see paragraph 2.7). To simplify the text, we named these two groups "Health group" and "Environment group", even if the additional information given in the form of messages referred only to some consequences for health[1] and the environment[2] linked to the production and consumption of the products studied in this work (the exact content of the messages is presented in paragraph 2.7).

Table 1 shows that the characteristics (sex, age, and level of education) of the panel and the two groups were close to those observed for the French population in terms of age group, sex, incomes, and level of education. The two groups were not different regarding these three criteria (age group: $\chi^2(2, N = 102) = 0.08$, $p = .97$; sex: $\chi^2(1, N = 102) = 0.16$, $p = .69$, level of education: $\chi^2(3, N = 102) = 0.87$, $p = .83$). Moreover, a questionnaire completed at the end of the study made it possible to characterize the consumption habits of the subjects and their knowledge about meat substitutes based on vegetable proteins. Comparison of the two groups revealed that the subjects in the Health group were more aware of the difference in composition between the two products (χ^2 (1, $N = 102$) = 27.69, $p < .0001$), more aware of the benefit of balancing the sources of proteins (χ^2 (1, $N = 102$) = 7.12, $p = .01$), and slightly more buyers of meat substitutes based on vegetable proteins (χ^2 (1, $N = 102$) = 5.54, $p = .04$). On the other hand, the two groups did not differ on the other characteristics (supplementary data, Table S1).

2.4. Products

[1] Balance of protein origin, fat, fatty acid and fiber intake
[2] Production of greenhouse gases, pollution, mobilization of cultivable areas

Two sausages belonging to the Herta brand were selected for this study: “Knacki Original” (pork) and “Knacki Végétale” (plant-based). The pork sausage (original recipe) of this brand is very popular, with a market share of 56% for the French market. The plant-based sausage, introduced in January 2018, has been the subject of a long process of research and development to obtain a product close to the original recipe in terms of appearance, taste and texture. Despite a similar appearance, the plant-based sausage differs from the original pork recipe because of the nature of the raw materials (pork versus wheat and peas) and their nutrient content. The plant-based product has a fat content of 19% (23% for the pork product) and a protein level of 16% (12% for the pork product). The price of the package of four plant-based sausages was higher than that of the package of four pork sausages (average prices observed in Dijon, France: 1.50 € versus 1.00 €, respectively). However, the exact prices and the price differences between the two variants varied slightly according to the point of sale.

The packaging of both products was available to the subjects during several stages of the experiment. The information on the packaging was as follows (both products): brand and name of products, list of ingredients and nutritional information, advice on the preparation and preservation of products, how to recycle the packaging after use, and other legal information (consumer service, traceability elements, etc.). Several pieces of information were specific to one or more of the products. The labels “100% pure pork” and “smoking on beech wood” were displayed on the front of the pork sausage packaging. The back of this packaging also included "a quality meat, 100% pure pork, without artificial colors, without polyphosphates, without plasma and without acidifier” and a logo reading "taste and quality". The front of the plant-based sausage packaging mentioned “Végétale” (plant-based), “Wheat, egg, pea”, and “Smoked vegetarian based on wheat, egg, and pea”. There was also a "vegetarian" logo (European vegetarian union). The back of the packaging of this product included the slogan "the plant as we like it" and a logo in the shape of ears of wheat.

2.5. Timeline of the experiment

The sessions began with general information about the experiment. The participants were informed that they would have to taste two samples of sausage (1/2 sausage per sample) three times and that they should give their preference and their WTP for two sausages. The exact nature of the products was not revealed at this stage. We insisted on the fact that no product would be sold or given at the end of the experiment. The reason given was that we could not fully guarantee the chilling of products from the lab to the participants’ refrigerators. We also insisted on the fact that all replies were anonymous and that there were no “good” or “bad” replies but the possibility to freely

indicate choices reflecting their preferences. After the subjects signed a consent form, the experiment began.

The experiment consisted of five stages (Figure 1). The first stage (Time-1) consisted of a blind tasting of both products, followed by the PP. In the second stage (Time-2), the subjects first received a package of each of the two sausages. The participants had a few minutes to observe them. Then, the corresponding samples were brought for tasting. The correspondence between the packages and the samples was ensured by coding the packages and samples with the same letter. After tasting, the participants gave their PP for one or the other sausage. Then, they filled in the price tables to give their WTP for the two sausages (one table per sausage). In the third stage (Time-3), participants received the first informative message on the environmental (Environment group) or health consequences (Health group) linked to the production and consumption of the two types of products (paragraph 2.7). After being exposed to the information, the participants gave their WTP. In the fourth stage (Time-4), participants received a second informative message, reinforcing the first. After being exposed to the information, the participants gave their WTP one last time. Finally, in the last stage of the experiment (Time-5), the participants gave their PP after having tasted the two products one last time.

2.6. Purchase preference (PP)

This measure indirectly assesses preferences by asking consumers which product they would be most likely to buy. On three occasions (Figure 1), participants had to give their PP for one or the other sausage after having tasted them. To do so, they had to answer the following question: "Imagine that you are in a purchase situation: after tasting both sausages, which one would you purchase?" The participants gave their answer by making a mark on a continuous scale ranging from "sausage A, without hesitation" (left bound) to "sausage B, without hesitation" (right bound). Sausage A was always the pork sausage, and sausage B was always the plant-based sausage. The label "one or the other, indifferently" was placed in the middle of the scale, reflecting an equivalent preference for both sausages. The labels "sausage A, probably" and "sausage B, probably" were positioned at 25 and 75% of the scale, respectively (Figure 2). It was possible for the subjects to click anywhere on the scale. Participants also had the option of ticking a box "neither of them" to indicate that they would not buy either of the two sausages. In this case, they should not make a mark on the scale.

2.7. Willingness to pay (WTP)

This measure indirectly assesses preferences from an economic point of view (economic value given to products based on available information). On three occasions (Figure 1), participants had to give

their WTP for each product. A multiple-price list was used for this purpose. Participants were asked to choose whether they would purchase the product for prices varying from 0.40 to 2.10 € (Figure 3). The average observed prices in Dijon were equal to 1.00 € for pork sausage and equal to 1.50 € for plant-based sausage. The multiple price list was characterized by increments of 10 cents, with 6 prices lower than 1.00 € and 6 prices higher than 1.50 €.

2.8. Informative messages (health and environment)

Information on the health and environmental consequences linked to the consumption of the two types of products was given in two stages, resulting in two WTP measurements. The information was given in two stages to study two levels of information. In fact, we do not know a priori the number of pieces of information necessary to observe an impact on consumers' preferences. The informative messages were on a paper document given to the participants and were also read aloud by the experimenter. The messages were written after studying articles coming from the nutrition, agronomic and environmental fields.

Health group

Additional information n°1: "Plant-based sausage is made from wheat and peas. From a nutritional point of view, it is advisable to combine the consumption of legumes, such as peas, with cereals, such as wheat, for a complete supply of essential amino acids and equivalence to meat. The consumption of more plant-derived proteins, e.g., from wheat and peas, and less animal protein contribute to a recommended rebalancing of the diet."

Additional information n°2: "The combination of pea and wheat in plant-based sausage explains the following composition differences compared to the pork sausage (original sausage). For the same quantities, the plant-based sausage contains 18% less fat and 75% less saturated fat compared to the pork sausage. In addition, it contains 8% more fiber. The decrease in fat and the increase in fiber contribute to a rebalancing of the recommended diet."

Environment group

Additional information n°1: "The production of pork sausage leads to the emission of much more greenhouse gases than the production of plant-based sausage. Nitrate pollution of groundwater and surface water is higher in pig farming than in cereal production areas."

Additional information n°2: "To produce 1 kg of animal protein, the animal must be supplied with approximately 4.9 kg of vegetable protein. The production of food for pigs utilizes large areas of cultivated land. Direct consumption of vegetable proteins, such as plant-based sausages, would save large areas of cropland and significantly reduce the use of pesticides and chemical fertilizers."

3. Data analysis

3.1. Data preparation

Missing data: Of the 122 initial participants, 20 were not considered for further analysis due to missing data (WTP and/or PP). We finally had a dataset including 102 participants.

PP (Figure 2): the mark on the scale gives a score ranging from -10 (high preference for sausage A) to +10 (high preference for sausage B). A score of zero indicates an equivalent preference for both products. These scores were used without transformation.

WTP (figure 3): For each product, the WTP was determined by taking the highest price linked to a choice “yes”. If the boxes "no" or "maybe" were ticked for all lines, the WTP was fixed to 0.40 € (the lowest value proposed). If for all lines the boxes “yes" were ticked, the WTP was fixed to 2.10 € (the highest proposed value). For respondents switching twice at low and high prices, the highest price corresponding to a “yes” was recorded as the WTP for the analysis.

3.2. Analyses

Purchase preferences (PP) according to taste

A t-test for one sample was carried out to determine whether the PP after blind tasting (scores ranging from -10 to +10) were oriented towards one or the other of the two products studied (comparison to a theoretical mean equal to zero). A PP score significantly less than zero would validate hypothesis 1.

Effect of packaging on purchase preferences (PP)

A repeated measures ANOVA using restricted maximum likelihood (REML) (model: PP score ~ subject, time) followed by a post hoc test (Tukey HSD, threshold set at 5%) made it possible to compare the PP obtained after blind tasting and after tasting with the packaging. The ANOVA was set up as follows: the fixed effect was “time”, the repeated factor was “time”, and the subject factor was “subject”. A t-test for one sample was carried out to determine whether the PP after tasting with packaging were oriented towards one or the other of the two products studied (comparison to a theoretical mean equal to zero).

The differences observed between the two PPs (times 1 & 2, Figure 1) would be attributable to the effect of the information carried by the packaging. A significant increase in PP scores following tasting with the packaging would validate hypothesis 2.

Effect of additional information on purchase preferences (PP)

A repeated measures ANOVA using restricted maximum likelihood (REML) (model: PP score ~ subject, group, time, time*group) followed by a post hoc test (Tukey HSD, threshold set at 5%) made it possible to compare the PP obtained after tasting with packaging and after the series of two messages. The ANOVA was set up as follows: the fixed effects were “time”, “group” and “time*group”, the repeated factor was “time”, and the subject factor was “subject”. A t-test for one sample was carried out to determine whether the PP after tasting with packaging were oriented towards one or the other of the two products studied (comparison to a theoretical mean equal to zero).

For each group of subjects, the differences observed between the PP obtained after tasting with packaging and after the series of two messages would be attributable to the cumulative effect of both messages. For each group of subjects, a significant increase in PP following the two messages would validate hypothesis 3.

Effect of additional information on willingness to pay (WTP)

For each product, a repeated measures ANOVA using restricted maximum likelihood (REML) (model: WTP ~ subject, group, time, time*group) followed by a post-hoc test (Tukey HSD, threshold set at 5%) made it possible to compare the WTP obtained after tasting with packaging, after the first informative message, and after the second informative message. The ANOVA was set up as follows: the fixed effects were “time”, “group” and “time*group”, the repeated factor was “time”, and the subject factor was “subject”. Finally, a series of t-tests (paired samples) was carried out in order to conclude as to the equivalence or the difference in WTP between the two products, for each of the stages and each of the two groups of subjects.

For each group of subjects, the difference observed between the average WTP after tasting with packaging and after the first message was attributed to the effect of the first informative message. In the same way, the difference observed between the average WTP after tasting with packaging and after the second message was attributed to the cumulative effect of both informative messages. An increase in WTP attributed to the plant-based product and/or a decrease in WTP attributed to the meat-based product would validate hypothesis 4. A decrease in the differences between the WTP obtained for the two products after dissemination of the informative messages would also validate hypothesis 4.

4. Results

4.1. Consumer purchase preferences (PP) related to sensory characteristics

The PP collected after blind tasting made it possible to study consumers' preferences with regard to the two sausages based on their sensory characteristics. The results show that consumers' preferences were clearly turned to meat sausage (hypothesis 1). The preference score was -6.2 on a scale from -10 (high preference for meat sausage) to +10 (high preference for vegetable protein sausage). This value is significantly lower than 0 ($t(101)$ = - 13.6, p < .001).

4.2. Effect of packaging on purchase preferences (PP)

The PP assigned after bind tasting and after tasting with packaging made it possible to study the effect of information carried by the packaging. The results of the ANOVA show that PP assigned during the two stages were significantly different (time factor: $F(1,101) = 15.6$, $p = .0001$). Figure 4a shows the average PP scores obtained after blind tasting (-6.2) and after tasting with packaging (-4.3) and the result of the multiple comparison test. The information included on the packaging influenced the PP towards a revaluation of the plant-based product (hypothesis 2). The PP score after tasting with the packaging, although higher than after blind tasting, remains significantly below zero ($t(101) = -7.76$, $p < .001$), meaning that the pork product remained significantly preferred.

4.3. Effect of additional information on purchase preferences (PP)

The PP assigned after tasting with packaging and after the informative messages made it possible to study the effect of information carried by the packaging. The ANOVA shows that, overall, after the two informative messages, the PP were significantly different from the PP obtained after tasting with the packaging (time factor: $F(1, 104) = 34.3$, p < .0001). In addition, belonging to one or the other of the two groups of subjects, therefore the fact of having received information about health or environmental concerns, seems to have had no influence (group factor: $F(1, 104) = 2.3$, $p = .13$). However, this conclusion must be moderated because the time*group interaction was slightly significant (time*group interaction: $F(1, 104) = 5.5$, $p = .021$), suggesting that the magnitude of the effect of informative messages was slightly different from one group of subjects to another. Figure 4b shows the average PP scores obtained after tasting with packaging (Health group: -3.9; Environment group: -4.7) and after informative messages (Health group: -0.9; Environment group: -3.4) and the results of the multiple comparison test. The results of the multiple comparison test of means confirm the time*group interaction. For the Health group, after the informative messages, the PP scores are significantly higher than after the tasting with the packaging ($p = .001$) (hypothesis 3). For the Environment group, although the value of the PP score obtained after the additional information was higher than after tasting with packaging, the difference was not significant according to the Tukey's test ($p = .31$). For Environment group, the PP score after informative messages remained significantly below zero ($t(49) = -4.1$, $p = .0002$), meaning that the pork product,

362 remained significantly preferred. On the other hand, for the Health group, the PP obtained after the
363 informative messages were not significantly different from zero ($t(51) = -0.99$, $p = .33$), meaning that
364 the PP for the two products were equivalent.

365

366 ### 4.4. Effect of informative messages on willingness to pay (WTP)

367 The WTP given after tasting with packaging, after the first information, and after the second
368 informative message made it possible to study the effect of the first informative message and the
369 cumulative effect of the two informative messages.

370 *WTP to pay for the pork product*

371 The results of the ANOVA performed show that, overall, the WTP for the pork product depends on
372 the different steps of the protocol (time factor: $F(2, 208) = 13.6$, $p < .001$). Moreover, WTP was
373 globally equivalent from one group to another (group factor: $F(1, 104) = 2.07$, $p = .15$), and the
374 group*time interaction was not significant ($F(2, 208) = 2.38$, $p = .10$). Thus, overall, having received
375 information about health or environmental concerns seems to have had no influence. However, this
376 conclusion should be moderate since the p value associated with the group factor is relatively close
377 to the threshold. In addition, the post hoc multiple comparison tests of means show some
378 differences between the two groups. Figure 5a shows the average WTP obtained for the pork
379 sausage after tasting with packaging (Health group: 1.25 €; Environment group: 1.47 €), after the
380 first message (Health group: 1.25 €; Environment group: 1.31 €), and after the second message
381 (Health group: 1.12 €; Environment group: 1.19 €), and the results of the multiple comparison test.

382 The first message about health did not cause any change regarding the WTP for the pork product (p
383 = 1.00), and the averages were even strictly identical. The second message about health caused a
384 decrease in WTP but the difference with WTP after tasting with the packaging was still not significant
385 ($p = .54$). Therefore, for the Health group, the cumulative effect of the two messages was not
386 sufficient to cause a significant decrease in WTP.

387 The first message about the environment caused a first decrease in the WTP for the pork product,
388 but, the difference with the WTP obtained after tasting with packaging was not significant ($p = .37$).
389 However, the cumulative effect of both messages about environment caused a further decrease in
390 WTP for pork sausage and, this time, the difference with the WTP obtained during the tasting with
391 the packaging was significant ($p = .01$). Therefore, for the Environment group, the cumulative effect
392 of the two messages was sufficient to cause a significant decrease in WTP.

393 *WTP for plant-based product*

The results of the ANOVA performed show that, overall, the WTP for the plant-based product depended on the different steps of the protocol (time factor: $F(2, 208) = 28.4$, $p < .001$). Moreover, WTP was globally equivalent from one group to another (Group factor: $F(1, 104) = .17$, $p = .69$), and the Group*Time interaction was not significant ($F(2, 208) = .21$, $p = .81$). Thus, the fact of having received information about health or environmental concerns had no influence. Figure 5b show the average WTP for the plant-based sausage, after tasting with packaging (Health group: 0.94 €; Environment group: 0.91 €), after the first message (Health group: 1.08 €; Environment group: 1.02 €), and after the second message (Health group: 1.14 €; Environment group: 1.09 €), and the results of the multiple comparison test.

For both groups, the first message about the environment caused a first increase in WTP for the plant-based sausage, but the difference with the WTP obtained after tasting with the packaging was not significant (Health group: $p = .08$; Environment group: $p = .31$). However, for the two groups, the WTP after the second message was significantly higher than during the tasting with packaging (Health group: $p = .002$; Environment group: $p = .01$). Therefore, for both groups, the cumulative effect of the two messages caused a significant increase in WTP.

Difference between the WTP of the two products

The comparison of the WTP obtained during the different stages made it possible to study the differences between the two products under the different information conditions. After tasting with packaging, the WTP of the two products were significantly different (delta: +0.43 euro for the meat product, $t(101) = 6,41$, $p < .001$). After the first and second health informative messages, the WTP of the two products were not significantly different (first message: delta: +0.17 euro for the meat product, $t(51) = 1.69$, $p = .10$; second message: delta: +0.02 euro for the plant-based product, $t(51 = -0.19$, $p = .85$). After the first environmentally informative message, the WTP of the two products were still different (delta: +0.30 euro for the meat product, $t(49) = 2.85$, $p = .006$). On the other hand, after the second message concerning the environment, the WTP of the two products were not different (delta: +0.10 euro for the meat product, $t(49) = 0.81$, $p = .42$).

In summary, for the two groups, the WTP after tasting with the packaging was significantly in favor of pork-based sausage and the combined effect of the two messages made it possible to achieve an equivalence between the WTP assigned to the two products (hypothesis 4).

5. Discussion

Purchase preferences (PP) according to sensory characteristics

Food choices and preferences result from a complex process involving many factors, including sensory characteristics. This is why the first step of this work was to measure blind PP, i.e., only by the appearance, texture, and flavors of both products. The analysis of PP based on blind tasting indicates that consumer preferences remain focused on the pork product. This result validates our first hypothesis (hypothesis 1), namely, that the vegetable protein substitute is less appreciated. The choice concerning the products of this study was therefore relevant, especially since the difference between the two products, according to taste, is important. This situation was therefore ideal to see to what extent information could revalue the vegetable protein product or at least reduce the gap between the meat product and its vegetable counterpart. Although no descriptive task was conducted during this experimentation, we can suppose that the sensory characteristics of the plant-based product are slightly atypical compared to the pork sausages currently available on the market. It is difficult to compare these results with the existing literature because the products studied and the methods for estimating the appreciation are rarely the same from one study to another. However, some studies have focused on the evaluation of meat and meat substitutes by consumers and have shown that meat substitutes lagged behind in the overall evaluation and in particular in sensory appreciation (McIlveen et al., 1999).

Influence of the packaging information on purchase preferences (PP)

Food choices and preferences are also guided by non-sensory characteristics, such as information included in packaging. In this experiment, the effect of the information included on the packaging of the two studied products could be evaluated by comparing the PP given after tasting with and without packaging information. Specifically, the revelation of the packaging information has allowed consumers to know, or perhaps for some of them to confirm, that one of the two sausages was made from vegetable ingredients. The effect of the information on both packages resulted in a significant increase in PP for the plant-based product, but it did not reverse preferences. Indeed, the PP collected after tasting with packaging information remained clearly focused on the pork sausage. This result validates our second hypothesis (hypothesis 2), namely, that the packaging allows a slight revaluation of the product based on vegetable proteins. However, this effect is not enough to reverse consumers' preferences. This suggests that the information on the packaging of these sausages is not sufficient to encourage consumers to consume the plant version rather than the animal version.

The differences between the PP given after the blind tasting and after the tasting with packaging information reflect the consumer interest in the non-sensory properties of the two products, specifically that of the plant-based product. The novelty of the product and/or the nutritional claims

on the packaging of the plant-based sausage may explain the increase in preference observed for this product. It can also be envisaged that the revelation of the true nature of the plant-based sausage clearly differentiated this product from the meat product universe, thereby changing the way in which the consumer compared the two products and causing a positive shift in consumer perception. Indeed, the atypical sensory characteristics of the plant-based sausage may be more easily accepted when it is clearly identified as a plant product. In addition, faced with current technological constraints to mimic a meat-like taste and texture, some authors propose to develop radically new meat substitutes, the so-called novel protein foods, which are not necessarily meat-like (Hoek et al., 2011). A recent work by Lemken et al. (2019) has shown that some German and New Zealand consumers would accept processed pulses if the products were not marketed as an alternative to meat. Another consumer group would prefer to replace meat directly with specific legumes rather than having highly processed products.

Influence of additional information

The information provided on the packaging of the plant-based product informs consumers about the ingredients used and their nutritional value. However, the level of knowledge of consumers regarding the impact on the health of a rebalancing of diets in favor of vegetable proteins is very variable. Moreover, the packaging of the plant-based sausage also displays a Vegetarian logo whose meaning and scope may vary from one consumer to another. Therefore, this experiment consisted of two consecutive information phases designed to study the reactions of the panelists to information concerning certain consequences for health and the environment linked to the production and consumption of these two types of products. We hypothesized that additional information (in addition to the information written on the packaging) about the health and environmental benefits of rebalancing diets in favor of plant protein could add value to the plant-based sausage and that this added value would result in an increase in the PP (hypothesis 3) and WTP (hypothesis 4) for the planted-based product (or at least a reduction in the differences observed between the two products).

Our results validate our hypotheses (3 & 4). In fact, the WTP for the plant-based product was significantly higher after the two informative messages. This result is valid for both groups. The results obtained also show an evolution in PP in favor of the vegetable protein product, but this increase is significant only for the group having received health-related information. The conclusions obtained with the two methods therefore differ slightly. Both approaches make it possible to study the impact of informative messages on the overall assessment of the two products studied. However, they do not measure exactly the same thing. The WTP reflects an overall appreciation of

each of the two products, while the PP are more likely to directly demonstrate a preference for either of the two products. It is not necessarily surprising that the results differ slightly. Despite these differences concerning one of the two groups, we can consider that the results are in general agreement. The differences between the two groups concerning the cumulative effect of the two informative messages on PP could be explained by a group effect. Indeed, the questionnaire completed at the end of the study made it possible to show that consumers of the Health group were initially more aware of the differences in composition between the two products studied, more aware of the importance of the balance of protein sources and more buyers of vegetable protein-based meat substitutes. Their knowledge of the Health group about plant-based products was therefore greater than that of the Environment group, which perhaps explains their greater receptivity or acceptance of the information disseminated. It is also conceivable that health information has had more impact than environmental information. The consequences for health are perhaps perceived as being more direct for consumers (and therefore more impactful) than the consequences for the environment. As the composition of the two groups varied on the three characteristics mentioned above and the information disseminated varied from one group to another, it is difficult to conclude definitively on the origin of the differences observed between both Health and Environment groups.

We also showed that, overall, it was necessary to combine two informative messages to observe a change in consumer preferences. Indeed, the increase in WTP and PP following the first message (environmental or health-related information) was not significant. This result suggests that the subjects involved in the study were not convinced by the information constituting the first message (health and environment) and therefore that they did not respond mechanically in the direction of the information given. On the other hand, they were convinced by the combination of the two messages. This suggests that the effectiveness of additional information depends on the nature of the information and/or the amount of information disseminated. As part of a communication campaign, it would therefore be necessary to test beforehand the impact of the information disseminated on consumers.

It is important to emphasize that after the distribution of the two informative messages, the WTP of the two products were equivalent (for the two groups) and that the PP of the Health group was not significantly different from zero. This is an encouraging sign because it shows that the type of messages used in this study makes it possible to obtain equality of products in terms of consumer preferences, whereas the meat product was preferred according to blind tasting and after tasting with packaging. This suggests that the establishment of consumer preferences results from a trade-off between the intrinsic and extrinsic characteristics of products and that the information provided

by the packaging is not sufficient to encourage consumers to orient themselves towards plant variants. Even if the diffusion of scientific information is often slow and imperfect in real contexts, this work underlined an important sensitivity of the participants, indicating potential evolutions and suggesting future possibilities of substitution between the two types of products. This means that in the long term, information campaigns could significantly influence preferences for plant-based products and change consumption habits. However, the most suitable mode of communication and the exact nature of the information to be disseminated remain to be determined. The information must be understandable by all and, if possible, not be added to the numerous information written on the packaging.

Limitations of the study

This study has several limitations. First, the choices made by consumers did not involve actual purchases. This limit is valid for most experiments involving hypothetical choices. The health risks linked to the transport of products from the laboratory to the home of the panelists have indeed led us to limit the protocol to hypothetical choices. On the other hand, we cannot exclude the possibility of social desirability bias. In a systematic review of recent literature, Cerri et al. (2019) point out that social desirability is one of the causes of common method biases social desirability bias in research using self-reported measures, including research on consumer responses to more sustainable foods. However, consumers were clearly informed at the start of the session that all responses were anonymous. We also insisted on the absence of good or bad replies and on the fact that participants had to try to answer as if they were buying from a supermarket. In addition, the panelists were installed in cabins, isolating the other participants and preserving their privacy. They could therefore express themselves freely by giving their answers. Anonymous data collection is considered by Cerri et al. (2019) as a possible procedural remedy to limit the bias of social desirability. To go further, we could have measured the need for social approval of each panelist and used this measure as a variable characterizing the panelists. The fact that the study relates to a single exposure is another limitation of this work. Even if the results obtained supplement current knowledge, it would be interesting to carry out a complementary study involving repeated measurements. Such measures are also recommended by Weinrich (2019). It is possible that over time and repeated exposures, preferences for plant-based sausage may increase. A study by Hoeck et al. (2013) has shown that the preferences of a group of consumers exposed twice a week over a period of 10 weeks to dishes containing meat or meat substitutes evolve gradually. Initially, the meat products were considered tastier, but as the exposures progressed, the differences between the meat and plant-based product diminished until they were no longer significant.

6. Conclusion

This case study based on a meat-based sausage and a vegetable protein-based counterpart shows that the information carried by the packaging makes it possible, to a certain extent, to orient consumers' PP towards plant-based sausage. However, consumers' preferences (PP and WTP) after tasting in the presence of the packaging remain focused on the meat-based product. We have shown that additional information, in addition to that carried by the packaging, relating to health or the environment would make it possible to promote the plant-based even more. We have shown that the dissemination of a first informative message concerning health or the environment was not enough to modify consumers' WTP. However, the combination of the two informative messages concerning the health consequences linked to the consumption of the two types of product made it possible to modify consumer preferences in favor of the plant-based product. These two messages made it possible to obtain an equivalence of the two products studied in terms of PP and WTP. The combination of the two environmentally informative messages also made it possible to obtain an equivalence of the two products studied in terms of WTP. On the other hand, the PP after these informative messages were not different from that expressed after the tasting with the packaging and still turned towards the pork product. This suggests that the impact of additional information depends on the information disseminated in the messages. It is also possible that the initial level of knowledge of the subjects has an influence on the receptiveness to the information disseminated. As part of a communication campaign, it would therefore be advisable to test the effectiveness of the information used before disseminating it on a large scale. Overall, these results militate in favor of the dissemination of information presenting the consequences of the consumption of meat-based or vegetable protein-based products. The appropriate medium to disseminate this information remains to be determined.

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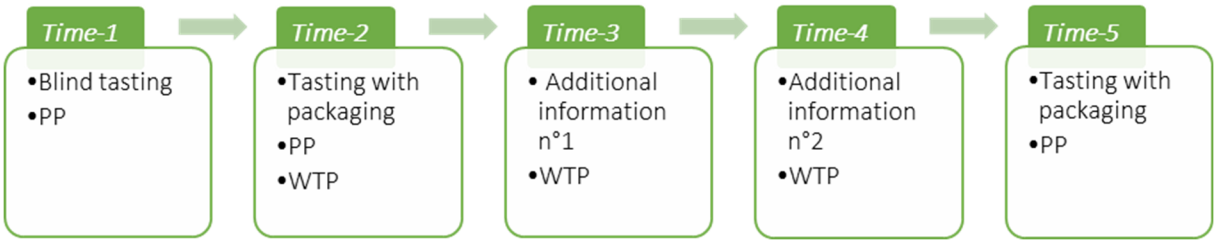

Figure 1: Timeline of the experiment. Both sausages were tasted at Time-1, Time-2, and Time-5. Purchase preferences (PP) were collected at Time-1, Time-2, and Time-5. Willingness to pay (WTP) were collected at Time-2, Time-3, and Time-4.

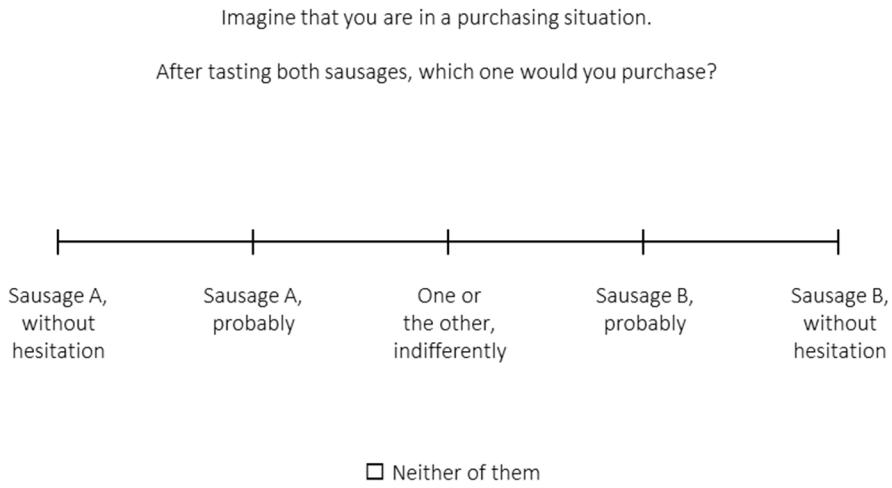

Figure 2: Scale used for measuring purchase preference (PP). Sausage A was always the pork sausage, and sausage B was always the plant-based sausage.

Would you purchase "sausage A at the following prices?

For each line, check off either "yes", "no", or "maybe".

Price	Yes	No	Maybe
0,40 €	☐	☐	☐
0,50 €	☐	☐	☐
0,60 €	☐	☐	☐
0,70€	☐	☐	☐
0,80 €	☐	☐	☐
0.90€	☐	☐	☐
1.00 €	☐	☐	☐
1.10 €	☐	☐	☐
1.20 €	☐	☐	☐
1.30 €	☐	☐	☐
1.40 €	☐	☐	☐
1.50 €	☐	☐	☐
1.60€	☐	☐	☐
1.70 €	☐	☐	☐
1.80 €	☐	☐	☐
1.90 €	☐	☐	☐
2.00 €	☐	☐	☐

Figure 3: Multiple-price list used for measuring willingness to pay (WTP) for each product

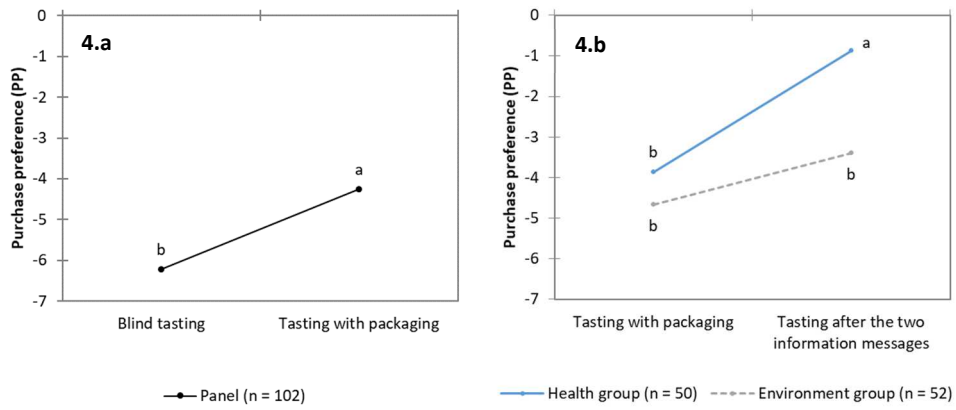

Figure 4: Effect of packaging information (4.a) and cumulative effect of both information messages (4.b) on purchase preferences (PP). PP scores ranged from -10 (pork product preferred) to 10 (plant-based product preferred). Zero indicates an equivalent preference for both products. For each graph, dots with different letters correspond to significantly different averages (Tukey's HSD test, p <0.05).

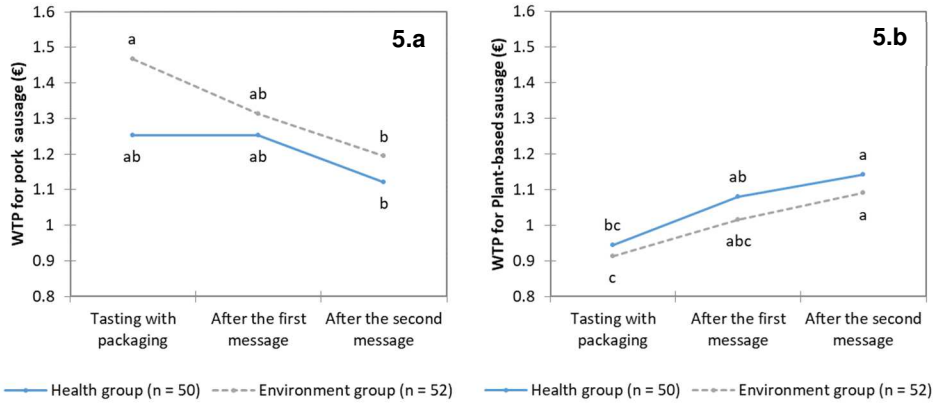

Figure 5: Cumulative effect of information messages on willingness to pay (WTP) for the pork (5.a) and plant-based products (5.b). Dots with different letters correspond to significantly different averages (Tukey's HSD test, p <0.05). Multiple comparison of means concerns the six points of each graph (one analysis)

Table 1: Panel, sociodemographic characteristics

		Health (n = 50)	Environment (n = 52)	All (n = 102)	French population[1]
Sex	Women (%)	48.1	54.0	51.0	51.6
	Men (%)	51.9	46.0	49.0	48.4
Age (year)	20-39 (%)	34.6	32.0	33.3	31.2
	40-59 (%)	32.7	30.0	31.4	34.4
	60 and over (%)	32.7	38.0	35.3	34.4
Level of education	< Baccalaureate[2] (%)	19.2	24.0	21.6	28.4
	Bac and bac + 2 (%)	40.4	44.0	42.2	40.3
	Higher than bac + 2 (%)	40.4	32.0	36.2	31.3

[1] 2018 figures, INSEE (National Institute of Statistics and Economic Studies)
[2] Baccalaureate (bac): French high school diploma