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ABSTRACT

The objective of this work was to study the reaction of consumers to a technological innovation (a radically new manufacturing process) applied to a traditional product (cheese). A traditional cheese and two cheeses resulting from a new sustainable process were evaluated by 142 consumers. These cheeses were first evaluated blind, giving rise to liking score and willingness to pay (WTP). Following a message concerning the nature of the processes used for the three cheeses, the consumers gave their WTP once again. The last two stages of the protocol consisted of successively revealing two pieces of information concerning the benefits of the new process for health and the environment and in measuring, at each of these two stages, the WTP of the consumers. Blind tasting showed that the two new cheeses were less appreciated than the traditional cheese. The information concerning the nature of the processes used did not significantly influence the WTP of the new cheeses but caused a revaluation of the traditional cheese. Information on the benefits of the new process has reduced the gap between the WTP of the three cheeses by decreasing the WTP for the traditional cheese and increasing the WTP for the new cheeses. This information made it possible to compensate for differences in liking of 1 to 2 points on a scale of 10. However, there is heterogeneity in consumer reactions. Indeed, some consumers (23%) did not appreciate the sensory properties of the new cheeses, and despite the assimilation of the information concerning the benefits of the new process, their WTP remained lower than those of traditional cheese. These results show that there is no major opposition to the application of technological innovations to traditional products such as cheese and that information concerning health and environmental benefits is positively accepted.

1. Introduction

Food innovations can positively contribute to the development of healthier and more sustainable food. However, despite various benefits in terms of health and the environment, food innovations often generate some reluctance among part of the population (Siegrist and Hartmann, 2020). Several factors explain this reluctance, such as new taste linked to a breakthrough process, fear of a loss of naturalness or traditional character, distrust of new technologies, and cultural habits with specific perceptions (Yang and Hobbs, 2020; Hindsley and Ashton Morgan, 2022). To improve the acceptability of innovative products that meet the challenges of tomorrow's food in terms of health and sustainability, it is necessary to better understand consumer reactions regarding these new foods and to highlight some possibilities allowing compensating for this reluctance (Guiné et al., 2020).

In the context of numerous innovations for foods, previous contributions delineated a clear frontier between consumer reluctance for some technologies, such as genetically modified organisms or nanofoods, and consumer acceptability for innovations preserving food identity, including naturalness, food integrity and tradition (Bieberstein et al., 2013; Frewer et al., 2011; Guiné et al., 2021; Lusk et al., 2005). The acceptance or rejection of innovations by consumers is the result of a complex decision-making process that involves an assessment of the perceived risks/benefits associated with the innovation (Ronteltap et al., 2007; Cavallo et al., 2020). Despite heterogeneous reactions depending on cultures, ethical values or incomes, several studies have shown that

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technological innovations can be accepted if consumers see an interest as the shelf life and safety and if the food is not distorted in its image, in its quality with "pure" ingredients and/or in its taste (Braghieri et al., 2014; Cavallo et al., 2020; Dettori et al., 2020; Guerrero et al., 2009, 2010; Rabadán, 2021; Vanhonacker et al., 2013). Despite this, technological innovations can be difficult to implement in traditional food products. Indeed, to be traditional, a food product must not only contain traditional ingredients but must also be processed in a traditional way and/or according to traditional recipes (Guiné et al., 2021). Consequently, process modifications are likely to call into question this traditional food status and lead to a reduction in consumer acceptability or even rejection. Moreover, consumers have often known and consumed traditional products for a long time. Thanks to repeated consumption, they were able to memorize and recognize the characteristic sensory properties of these products. Therefore, even small changes in sensory quality are likely to be easily detected by regular consumers. The boundary between acceptable and unacceptable changes is difficult to determine a priori. For this reason, testing the acceptability of new products before launching them on the market is strongly recommended (Guerrero et al., 2009; Vanhonacker et al., 2013).

It would be interesting to better understand how consumers arbitrate information about new products developed with the aim of increasing sustainability. Indeed, food products with health and environmental benefits may not be accepted because of their novelty, especially in the case of traditional products.

The objective of this work was to study the reaction of consumers to a technological innovation (a radically new manufacturing process) applied to a traditional product (cheese). In particular, we wanted to better understand the way in which consumers assimilate and arbitrate the information available, namely, the taste of the products, the nature of the process used, and information concerning the benefits of the innovative process for health and the environment.

Two main hypotheses, associated with these questions, were tested in this study. The first one was to understand whether or not consumers would react negatively following information about the new process. Indeed, cheese is a product that is part of the French culinary tradition and it was likely that a modification in the classic process would lead to some reluctance or mistrust. Therefore, we expected that the disclosure of the nature of the processes used would lead to a reduction in willingness to pay (WTP) for the new cheeses. The second hypothesis was that consumers would be sensitive to information about the benefits of the new process in terms of health and the environment. Therefore, we could expect an increase in WTP for the two new cheeses after information about the advantages of the new process was revealed. In addition, a liking measurement was performed to assess the acceptability of the new cheeses selected for this study, compared to a commercial reference cheese. Although a particular attention was paid to the choice of ingredients and the production of the new cheeses, we expected a lower hedonic appreciation for those products, in particular because the new process involves accepting a compromise between sensory properties on the one hand and the quality of nutritional and environmental properties on the other.

The conclusions drawn from this study provide elements of understanding that can be used in the development of new, more sustainable food products.

2. Materials and methods

2.1. Experimental conditions

The experiment was conducted in December 2021 in a tasting room at the INRAE (National Research Institute for Agriculture, Food and Environment). The local ethics Committee for Research (Université Bourgogne-Franche-Comté) approved this study (# CERUBFC-2021-05-12-009). Individuals received oral and written information about the study and gave written informed consent before participating. They received €10 compensation for their participation in a session lasting approximately 1 h.

2.2. Participants

A sample of 142 regular consumers of cheese and in particular of bloomy rind soft cheese (including occasional consumers) living in the area of Dijon (France) was selected for this experiment. For the purposes of the study, these 142 subjects were randomly divided into two groups to obtain a variation in the order of the revelation of information (see paragraph 2.4). Group A received information concerning health and then information concerning the environment. Group B received the information in the reverse order. Each session included only eight subjects, i.e., 50% of the capacity of the tasting room to comply with the instructions related to the COVID-19 pandemic. For each session, the subjects belonged to either Group A or Group B.

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, sex, and level of education (Chi^2, $p > 0.05$). Groups A and B were not different in terms of age and level of education, but there were more women in Group A than in Group B, while Group B had more men ($Chi2 = 8.989$, $p = 0.003$).

2.3. Products

2.3.1. Commercial cheese (classic process)

The commercial cheese (CC), whose trade name was L'Ortolan® was produced by the Milleret cheese dairy (Bourgogne-Franche-Comté, France) and bought in a supermarket (Centre Leclerc, Rennes, France). This cheese, popular in France, was chosen because it was representative of soft Camembert-type cheeses produced by the cheese industry, both in terms of manufacturing process and sensory characteristics. L'Ortolan® was obtained with a classic process based on four successive steps: coagulation, draining, salting and ripening. At the time of this experiment, the price was approximately €2.00 in Dijon supermarkets (€1.97 - €2.05). L'Ortolan was marketed in a 250 g size and was packaged in paper (aluminum) packaging. The list of ingredients appearing on the packaging was as follows: pasteurized cow's milk (France), salt, and ferments. It was also specified that the cheese did not contain lactose or animal rennet and that it was suitable for vegetarians. The characteristics highlighted by the manufacturer on the packaging of L'Ortolan® were "soft and natural cheese." For convenience, for this commercial cheese produced with a conventional process, we will sometimes use in this document the term "traditional cheese".

Table 1
Panel and sociodemographic characteristics.

		Group A (n = 69)	Group B (n = 73)	All (n = 142)	French Population[1]
Sex	Women (%)	60.9	39.7	50	51.6
	Men (%)	39.1	60.3	50	48.4
Age (year)	20–39 (%)	33.3	32.9	33.1	31.2
	40–59 (%)	40.6	27.4	33.8	34.4
	60 and over (%)	26.1	39.7	33.1	34.4
Level of education	< Baccalaureate (%)[2]	17.4	15.1	23	28.4
	Bac and bac + 2 (%)	37.7	43.8	61	40.3
	Higher than bac + 2 (%)	44.9	41.1	58	31.3

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

2.3.2. Experimental cheeses (new process)

The two experimental cheeses were produced using an innovative process patented by INRAE (Garric et al., 2016). The cheeses were made by the dairy platform (UMR 1253, STLO, Rennes), which respected all necessary food safety procedures. The Departmental directorate for the protection of populations (DDPP) of Rennes (France) validated the health control plan (Hazard Analysis Critical Control Point). An accredited laboratory (LABOCEA, Fougères, France) performed microbiological analyses of four pathogens on all our products after demolding (*Listeria monocytogenes*, *Salmonella* spp., Coagulase-positive *Staphylococci* and *Escherichia coli*). For convenience, both cheeses produced by the new process, will sometimes be called "new cheeses" in this document.

The process principle is presented in Fig. 1. The first step of the new process consisted in separately manufacturing a "texture" matrix and an "aromatic" matrix. With the new process, the elimination of water, ensured by the step of draining in the traditional process, was replaced by ultrafiltration. The separate production of the aromatic matrix allowed the aromas to be produced quickly under controlled conditions. The two matrices were then mixed with the addition of salt and acidifying agent (glucono-delta-lactone). After a short acidification, and addition of rennet, the liquid mixture was placed in molds and then incubated. The continuation of the process, i.e. the development of the surface flora (*Penicillium camemberti* and *Geotrichum candidum*), was similar to the traditional process. For more details on the different steps and on the physicochemical characteristics, see Harel-Oger et al., 2022.

After 9 days of ripening, the soft cheese was packed and stored overnight at 4 °C. The next day, the products were packed in a classic camembert box just before their transport at 4 °C in a refrigerated vehicle to the place of experimentation (INRAE, Dijon, France). The commercial cheese was transported at the same time and under the same conditions as the two experimental cheeses. The three cheeses were stored at 4 °C over a period of 3.5 (minimum) to 7.5 days (maximum) before they were consumed during the experimental sessions.

The new process, breaking with the traditional process, offers a technical solution meeting the challenges of sustainability and food health of the future. Indeed, the new process allows us to produce cheeses containing approximately 20% less salt, without a significant reduction in the intensity of the salty taste (see Harel-Oger et al., 2022). Additionally, it makes it possible to produce cheeses richer in protein because the proteins are better recovered in the new process (protein recovery rate of 96% against 82% in the traditional process). Moreover, the new process saves 25% of water and energy compared to the classic process (Chamberland et al., 2019). Finally, it generates less polluting discharges because the proteins are better preserved during the draining stage, whereas they are discharged into the whey in the classic process: 6 g/L of proteins in the whey for the classic process against less than 0.5 g/L for the new process. It should be emphasized that, compared to the classic process, this new process does not involve any additives but that the innovation is based on a reorganization of unit operations.

The manufacturing protocols for these two new cheeses (NC) were developed with the aim of achieving, on the one hand, a cheese with a mild flavor and buttery notes (NCMF) in the spirit of commercial cheese and, on the other hand, a more typical flavor close to farmhouse cheeses (NCTF). Fig. 2 shows the appearance of the three cheeses studied. As can be seen, the two cheeses obtained with the new process (NCMF and NCTF) had a surface flora comparable to that of commercial cheese (CC), or at least to certain commercial cheeses. On the other hand, the cheese paste of two new cheeses was apparently more compact and had very few air cells, compared to commercial cheese. This appearance is inherent to the new process. A longer ripening would have made it possible to obtain a softer cheese paste, but to the detriment of the environmental advantages of the new cheeses. The ripening step is indeed energy consuming. We were aware that these sensory characteristics were likely to influence consumer appreciation, but we wanted to test products that maximized environmental benefits.

2.3.3. Sample preparation

The cheeses were kept in a cold room at 4 °C. One hour before the session, the cheeses were removed and placed at room temperature. Slicing (1/8 cheese per sample, i.e., approximately 30 g) took place 20 min before the session to avoid desiccation. After slicing, the samples were placed on plates coded with a three-digit number. The same codes were used for the entire experiment. Each cheese therefore had a single code. Each plate contained 2 samples of the same cheese. The three plates were placed in the tasting booths just before the arrival of the subjects. For each cheese, the first sample was used for Step 1, and the second was used for Step 3 (Fig. 3). The internal temperature of the samples during Step 1 was approximately 10 °C. The appearance of different products offered to participants is presented in Fig. 2.

2.4. Successive steps of the experiment

The sessions began with general information about the experiment, followed by the reading of the information sheet detailing the conditions of participation and the reciprocal commitments of experimenters and participants. Then, the subjects signed the consent form, and the experiment could begin. The successive steps of the complete procedure are illustrated in Fig. 3. For steps 1 to 5, the three cheeses were evaluated. For a given subject, the order of cheese evaluation was the same for all five stages. For a given session, all subjects had the same order. However, the order of cheese presentation varied from one session to another. In this way, the order of cheese presentation was balanced across the entire panel.

Step 1: The subjects were asked to rate their overall liking of each cheese on a linear scale. The subjects were informed not to touch the second sample reserved for stage 3. Then, subjects had to give their WTP for each cheese using a multiprice list (Fig. 4).

Step 2: The subjects were asked to successively taste the three cheeses and specify their level of satisfaction with nine sensory properties.[1] For this step, the subjects used the second sample provided. Step 2 is not detailed in this paper, but all the numerous details about this step are given by Harel-Oger et al. (2022).

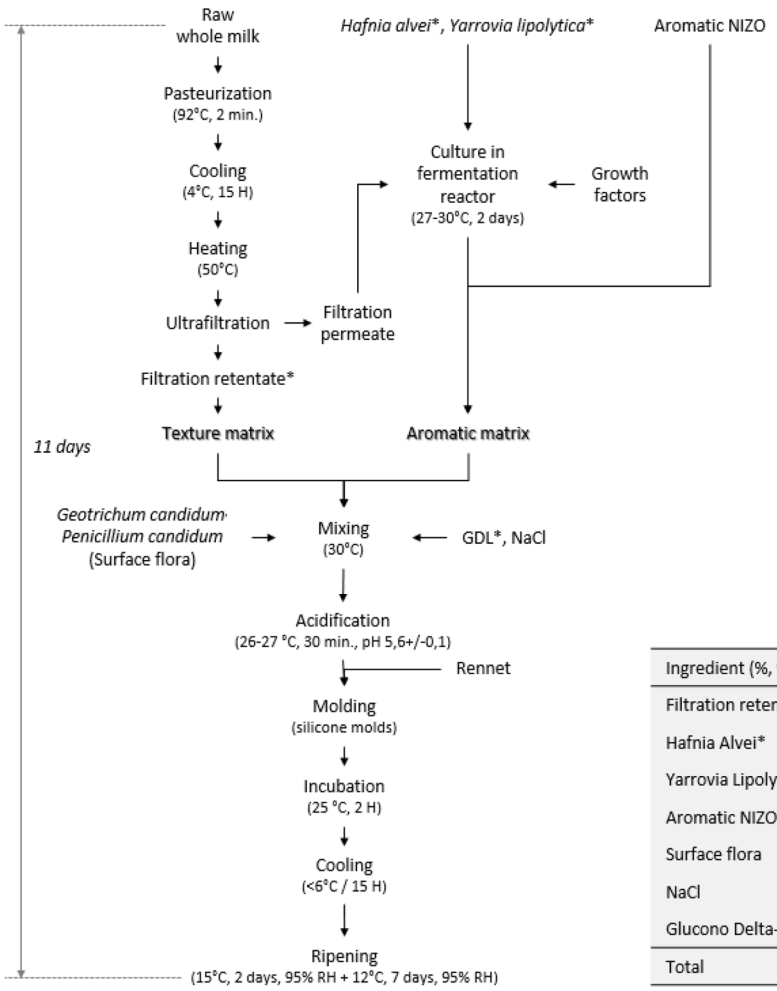
Step 3: After obtaining information about the manufacturing processes of the three cheeses (see paragraph 2.7.1), the subjects had to give their WTP. For each product, a fictitious label including a brand name as well as a brief description of the expected taste was created, especially for this study. We have chosen to replace the actual name of the commercial product so that consumers do not refer to a known brand or product and focus only on the taste of the product and the nature of the process used. To remain in the spirit of the actual name of the commercial product, we have chosen to name all cheeses with bird names.[2] Thus, the commercial cheese (CC) was renamed "Chardonneret", and the two experimental products were named "Alouette." The claim "doux et naturel" (sweet and natural) of the commercial cheese (CC) was kept and used for the new cheese with à mild flavor (NCMF). The new cheese NCTF received the claim "de caractère" (strong cheese) to take into account the sensory characteristics conferred by the ferments used. These labels were also used for steps 4 and 5.

Step 4: The subjects received information concerning the advantages for health (Group 1) or the environment (Group 2) linked to the new cheese-making process and then had to give their WTP again. Both messages are detailed in paragraphs 2.7.2 and 2.7.3.

Step 5: The subjects received information concerning the advantages for the environment (Group 1) or health (Group 2) linked to the new cheese-making process and then had to give their willingness to pay again.

[1] Sensory properties studied: appearance of the rind, cheese paste color, intensity of smell, firmness, fatty/sticky, homogeneous/smooth, salty taste, fruity note, and character.

[2] "Ortolan" is a small bird.



Ingredient (%, w/w)	NCTF	NCMF
Filtration retentate*	90.5	95.2
Hafnia Alvei*	4.0	-
Yarrovia Lipolytica*	0,5	-
Aromatic NIZO	2.0	2.0
Surface flora	2 doses	2 doses
NaCl	1	1
Glucono Delta-Lactone (GDL)*	2.0	1.8
Total	100	100

Fig. 1. Principle of the *From'Innov* process (new process). The * indicates the differences between the two experimental cheeses NCTF and NCMF.

Step 6: The subjects had to answer a questionnaire intended to collect sociodemographic characteristics and to identify their consumption habits and attitudes toward new foods. The questions concerned the following variables: age, sex, socioprofessional category, income, education level, number of people in the household and number of children, responsibility for household purchases, frequency of meat consumption, frequency of consumption of different cheeses, type of cheeses preferred and most consumed, purchase of cheese from organic farming, main criteria for buying cheese, knowledge and beliefs about cheese and its quality and properties, beliefs about new foods, and projection of cheese consumption in years to come.

Note that for steps 3, 4, and 5, the subjects did not taste the products. Subjects could view the responses given in the first step and could choose to change or maintain their answers.

The sessions lasted a maximum of 1 h, including the reception of participants, explanations of the protocol by itself, and the payment of the compensation (10€ per participant). Therefore, the duration of the experiment itself was close to 45 min. This duration is classic for this kind of experiment. No participant complained about the workload and the experimenters did not detect any sign of fatigue for participants.

2.5. Overall liking measurement

After tasting the three samples in the specified order, the subjects were asked to rate their liking on a linear scale with "I do not like at all" and "I really like" labels at the start and end of the scale, respectively. For each cheese, it was possible for the subjects to click anywhere on the scale.

The instructions given were as follows. "Observe and taste the 3 samples, then indicate your overall liking on the scales below. For each product, you can tick where you want on the scale according to your appreciation. You must tick the three scales, each corresponding to a product whose code is displayed on the left.".

2.6. Willingness to pay (WTP)

A multiple-price list was used to collect the willingness to pay (steps 1, 3, 4, and 5). Participants were asked to choose whether they would buy the product for prices varying from €1.00 to 3.00 (Fig. 4). The average observed prices in Dijon were approximately equal to €2.00 for Camembert cheese. The multiple price list was characterized by increments of 10 cents, with 10 prices lower than €2.00 and 10 prices higher than €2.00.

The question asked was: "Would you buy one unit of a 250 g product (weight of a standard box/package of Camembert) at the listed price?" To give their answers, the subjects had to tick a box ("Yes", "No", or "Maybe") for each of the prices on the list.

The subjects were informed that the willingness to pay they would indicate did not involve actually purchasing the products. The choices were virtual, and there were no product sales. We emphasized that there were no right or wrong answers and that participants should simply answer as if they were in a shopping situation in a supermarket.

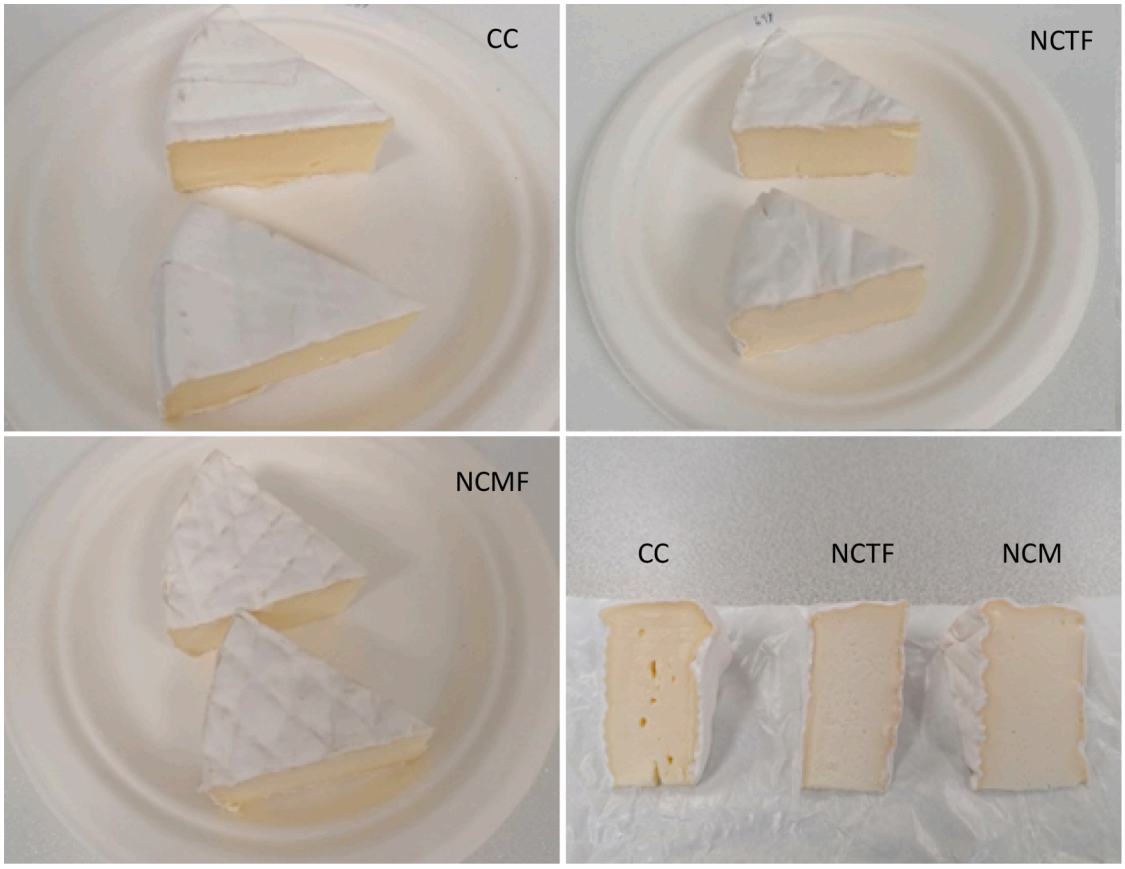


Fig. 2. Appearance of the three cheeses studied: commercial cheese (CC), new cheese, typical flavor (NCTF), new cheese, mild flavor (NCMF).

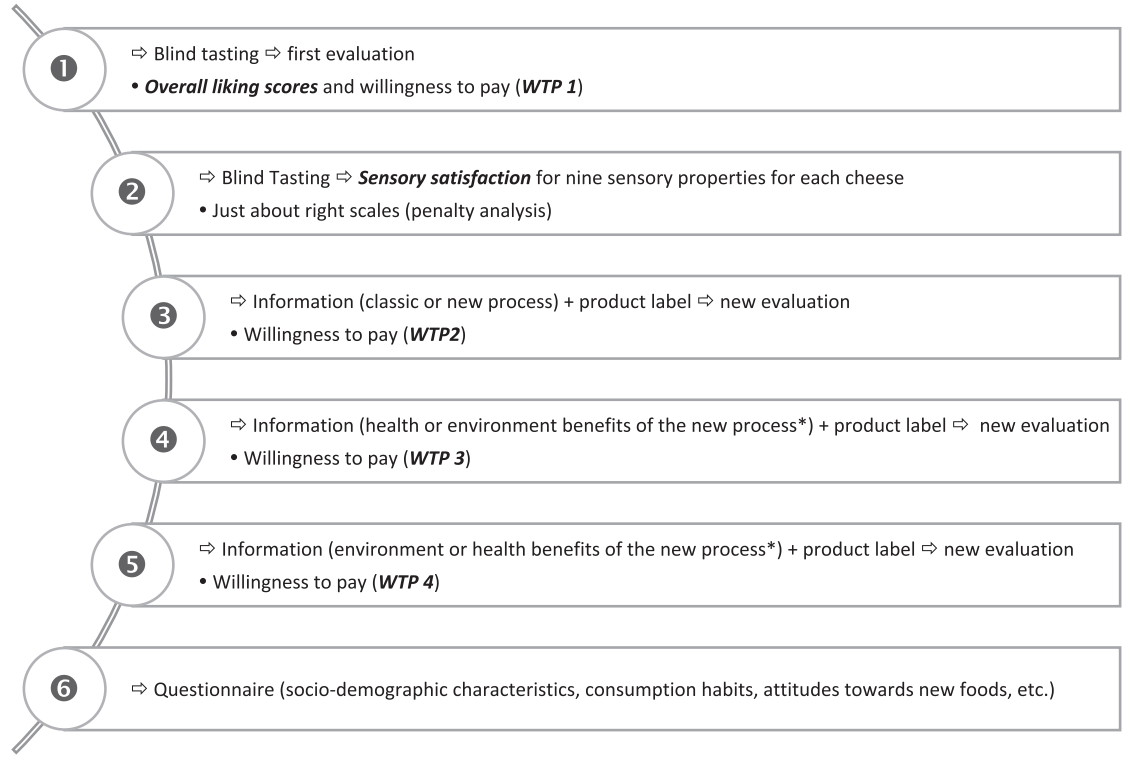


Fig. 3. Successive steps of the experiments.

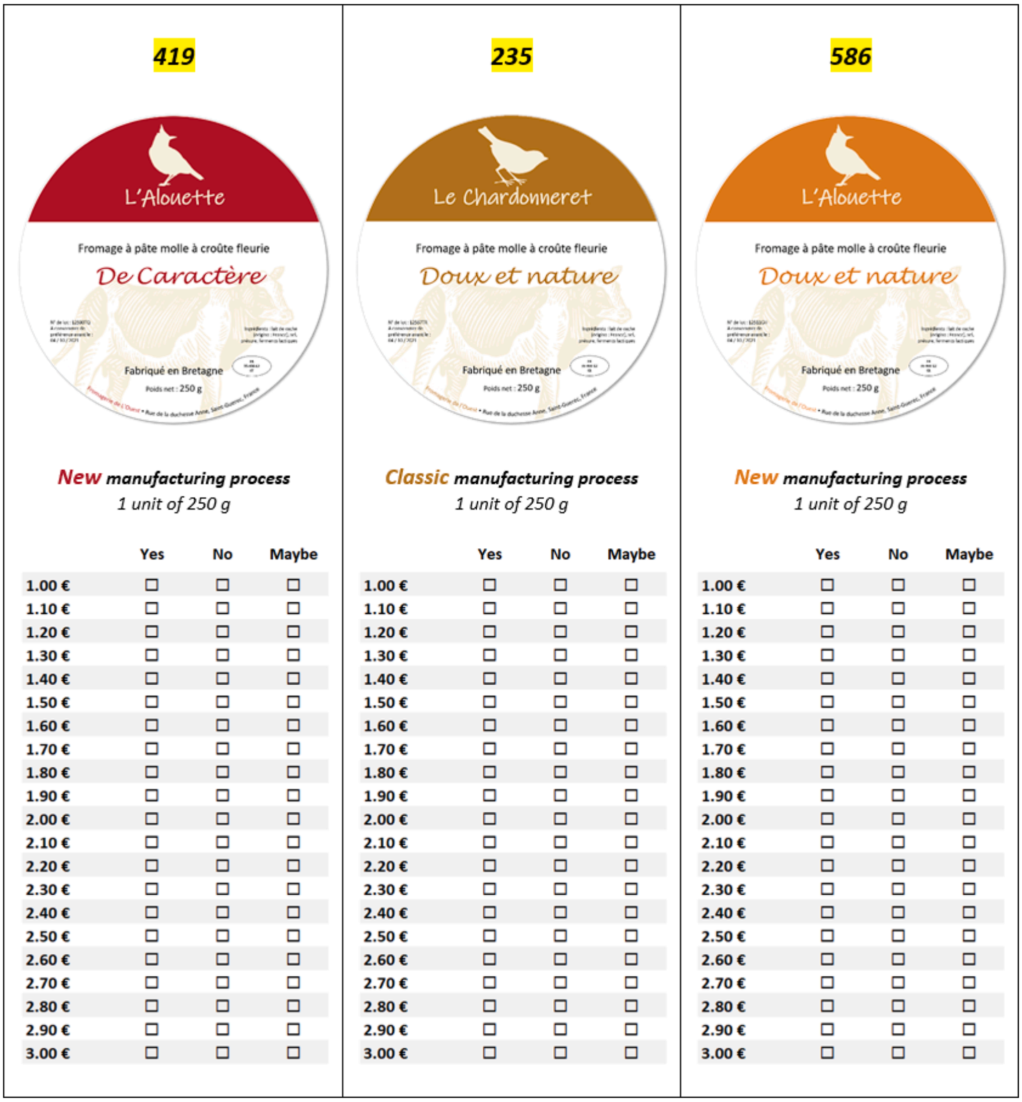


Fig. 4. Multiple-price list used for measuring willingness to pay (WTP) for each product. Labels and mentions referring to the manufacturing process only appeared for steps 3, 4 and 5. For step 1, there were only product codes and price lists. For the experiment, NCTF, CC, and NCMF were respectively coded 419, 235, and 586.

2.7. *Information messages*

All the information was given at each stage (3, 4 and 5) on sheets for the subjects to read. In addition, the experimenter read these instructions aloud. The subjects had the opportunity to ask questions if necessary.

2.7.1. *Manufacturing process*

During stage 3, the information given concerning the new manufacturing process was as follows: “A new manufacturing process has been developed by INRAE. It makes it possible to obtain cheeses by following a manufacturing process different from the traditional process. Compared to the traditional cheese-making process (coagulation, draining, salting then ripening), the new process reorganizes the manufacturing phases (draining, salting, ripening and coagulation). The optimization of the stages makes it possible to obtain a finished product that can be consumed 7 days after manufacture, compared to 15 days for a conventional process.

2.7.2. *Health benefits linked to the new manufacturing process*

The information given was as follows: “The new process allows producing cheeses of better nutritional quality. It makes it possible to obtain cheeses containing approximately 20% less salt, without a significant reduction in the intensity of the salty taste. Additionally, it makes it possible to obtain cheeses richer in protein because the proteins are better recovered in the new process (protein recovery rate of 96% against 82% in the traditional process)”.

2.7.3. *Environmental benefits linked to the new manufacturing process*

The information given was as follows: “The new manufacturing process is more respectful of the environment. It saves 25% of water and energy compared to the classic process. Additionally, it generates less polluting discharges because the proteins are better preserved during the draining stage, whereas they are discharged into the whey in the classic process: 6 g/L of proteins in the whey for the classic process against less than 0.5 g/L for the new manufacturing process.”.

3. Data analysis

3.1. *Data preparation*

The marks made on the liking scales resulted in continuous scores ranging from 0 (“I did not like at all”) to 10 (“I really like”). For each product, the WTP was determined by taking the highest price linked to a

Table 2
Global impact of health and environmental information on WTP (Model n°1) and effect of the order in which this information is given (Model n°2): estimated coefficients (EC) coming from the regression (random effect Tobit model), p value associated with Student's t (test), and Standard errors (SE).

Independent variables (1/0)	WTP Model n°1			WTP Model n°2		
	EC[1]	p value[2]	SE	EC[1]	p value[2]	SE
Cheese CC[3]	1.73	**	0.11	1.37	**	0.11
Cheese CC[3] × Messages	−0.24		0.14	–		
Cheese CC[3] × Messages × Health First	–			−0.14		0.18
Cheese CC[3] × Messages × Environ. First	–			−0.34		0.18
Cheese NCTF[4]	0.95	**	0.11	0.95	**	0.11
Cheese NCTF[4] × Messages	0.36	*	0.15	–		
Cheese NCTF[4] × Messages × Health First	–			0.43	*	0.18
Cheese NCTF[4] × Messages × Environ. First	–			0.29		0.18
Cheese NCMF[5]	0.76	**	0.11	0.76	**	0.11
Cheese NCMF[5] × Messages	0.52	**	0.15	–		
Cheese NCMF[5] × Messages × Health First	–			0.64	**	0.18
Cheese NCMF[5] × Messages × Environ. First	–			0.40	*	0.18
Stand. devi ε (random effect of the estimator)	1.21	**	0.04	1.20	**	0.04
Stand. dev. μ [b] (tobit part of the estimator)	0.56	**	0.06	0.56	**	0.06
Observations	N = 852			N = 852		
Log likelihood	−1269.7			−1268.7		

[1] Estimated coefficient or "-" (variable not used in the model).
[2] p value associated with Student's t: ** p value < 0.01; * p value < 0.05.
[3] CC: commercial cheese.
[4] NCTF: new cheese, typical flavor.
[5] NCMF: new cheese, mild flavor.

choice "yes". If the boxes "no" or "maybe" were ticked for all lines, the WTP was fixed to €0. If for all lines the boxes "yes" were ticked, the WTP was fixed to €3.00 (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

Chi-square tests were used to compare age and sex characteristics of the entire panel and the two groups to each other and to the population.

The liking scores given to the three cheeses after blind tasting were analyzed using a two-factor variance analysis (ANOVA, type III) whose model was as follows: liking = subject + product + error. This analysis was followed by a multiple comparison test of means (Tukey HSD, threshold set at 5%) to study the differences between the mean scores of the three cheeses.

The following options were used for agglomerative hierarchical clustering (AHC) performed on liking data to study possible heterogeneity within the panel: Euclidean distance (proximity type, dissimilarities), Ward method (agglomeration method), and automatic truncation (entropy).

The differences in appreciation between the two groups of consumers obtained with the AHC were tested using a two-sample *t* test (one analysis per product, threshold set at 5%).

The links between liking scores and willingness to pay were studied using the Pearson correlation coefficient.

For the WTP, average values were presented for different products and for the different steps at which WTP were elicited. Some Wilcoxon tests were performed to compare paired sample WTP and measure the statistical significance of differences between WTP elicited for different products and different steps.

Eventually, the impacts of messages on WTP were also analyzed with several regressions (random effect Tobit model) to obtain additional details captured by dummy variables (DV) equal to 1 for a corresponding characteristic or zero otherwise. Given that each Participant i wrote several WTP for several products, errors related to these WTP are potentially correlated to each participant. The random effect imposes constraints on the structure of the variance–covariance matrix. Furthermore, a WTP cannot be negative and is left-censored at zero, which is why we use the random effects Tobit estimator. We used the R package *pglm*, which approximates the likelihood function via a Gauss–Hermite quadrature.

Model n°1 takes into account, for each product, the global effect of the information concerning the benefits of the new process for health and the environment. Model n°2, built on the basis of the first, makes it possible to test, in addition, the effect of the order of the information concerning the health and environmental benefits. Model n°3 makes it possible to take into account the two groups of consumers determined according to the liking scores given during the blind tasting.

Two variables from the exit questionnaire (see Fig. 3, step 6) were used in regression Models n°4 and n°5. A "Quality of Food" index, considering the answers to 11 questions on attitudes toward food quality, was calculated. For each question, completely in favor is mapped to 1.5; rather in favor to 0.5; does not know corresponds to 0; rather not in favor is mapped to −0.5 and not at all in favor to −1.5. The average of the values was taken over the 11 questions. The second variable used in the regression model is the response to a question regarding consumer attitude when tasting new foods. The response was coded 1 if a participant replied "enthusiastic and curious" to a question and 0 otherwise.

For Models n°1 to n°4, only WTP-2 (no information except sensory properties and process used) and WTP-4 (complete information) were used. This is equivalent to testing the overall effect of the information (nature of the process, health and environmental benefits). For each subject, 6 WTP were therefore considered: 3 cheeses × 2 stages (WTP-2 and WTP-4).

For Model n°5, only WTP-1, given after blind tasting, and WTP-2 (no information except sensory properties and process used) were used. This is equivalent to testing the effect of the information concerning the nature of the process. For each subject, 6 WTP were therefore considered: 3 cheeses × 2 stages (WTP-1 and WTP-2).

4. Results

4.1. Liking (blind tasting)

4.1.1. Differences between products

The analysis of variance showed that there were significant differences between the products ($F(2,282) = 25.52, p < 0.0001$). Fig. 5 shows the average liking scores obtained by the three products. According to blind tasting, the traditional cheese (CC) was significantly preferred to new cheese with the typical flavor (NCTF). New cheese with the mild flavor (NCMF) was the least preferred of the three products studied. However, it should be noted that the average score obtained by this last product corresponds to the middle of the liking scale.

4.1.2. Heterogeneity of the consumer panel

Agglomerative hierarchical clustering (AHC) performed on liking data suggests that, according to blind tasting, there were two groups of consumers with distinct preferences (Fig. 6). Group 1 (in red in Fig. 6) includes 109 consumers, while Group 2 (in blue in Fig. 6) includes 33 (i.

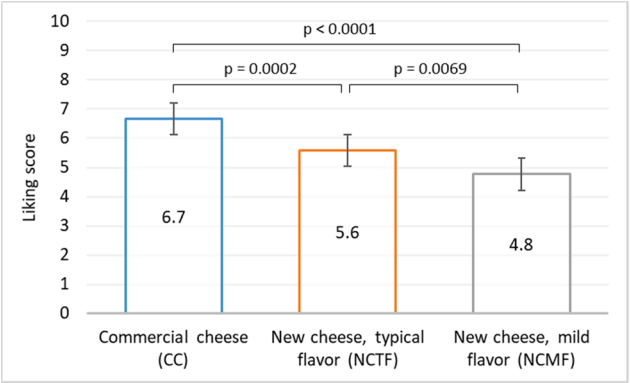


Fig. 5. Liking scores obtained by the three products (average liking score, standard error, and p value from the Tukey HSD test). Liking scores obtained using an unstructured linear scale, ranging from "I don't like it at all" (left end, score = 0) to I like it a lot (right end, score = 10).

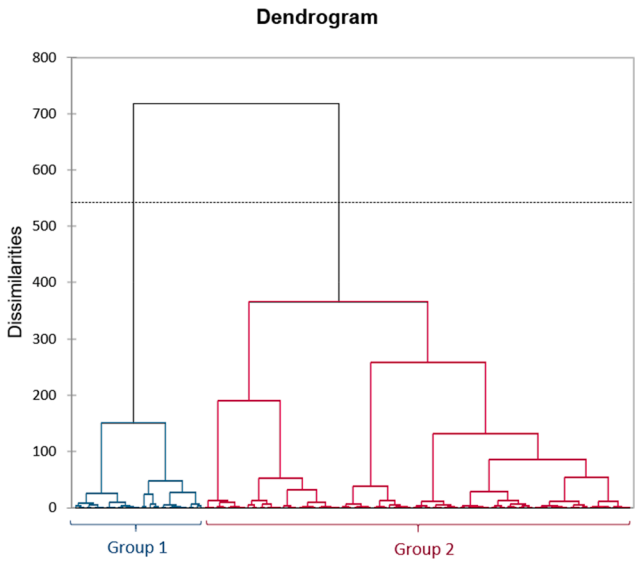


Fig. 6. Dendrogram from AHC performed on liking data (blind tasting).

e., 23% of the panel).

The mean scores of the two groups formed by the AHC were not significantly different for the traditional cheese CC ($t(140) = 1.41$, $p = 0.161$). However, the preferences of these two groups diverge significantly for the new cheeses NCTF ($t(140) = 11.49$, $p < 0.0001$) and NCMF ($t(140) = 7.28$, $p < 0.0001$). Indeed, consumers belonging to Group 2 (n = 33) liked these products less than consumers from Group 1 (n = 109) (Fig. 7).

No variable from the questionnaire completed in step 6 made it possible to learn more about the origin of the differences observed for these two groups of consumers.

4.1.3. Link between liking and WTP

A correlation was observed between the liking scores and the willingness to pay given following blind tasting ($r(424) = 0.70$, $p < 0.0001$).

4.2. Willingness to pay

Fig. 8 presents the evolution of WTP during the Experiment: a) for all consumers, b) for consumers belonging to Group 1 (n = 109), and c) for consumers belonging to Group 2 (n = 33). The successive WTP-Z, with Z = {1, 2, 3, 4}, is represented on the X-axis, and the average value of WTP in € is represented on the Y-axis.

Fig. 8a shows that there were differences between the initial WTP (WTP-1) for the different products and that the ranking of these WTP were consistent with the liking scores given under the same evaluation condition (Fig. 5).

The comparison of WTP-1 and 2 makes it possible to evaluate the impact of information concerning the nature of the processes used for the manufacture of cheeses. This information tended to increase the difference between WTP for the traditional cheese CC and both new cheeses (NCTF and NCMF). The increase in this distance was due more to an increase in the WTP for the traditional cheese than to a change in the willingness to pay for the two new cheeses (no significant difference between WTP-1 and WTP-2 for NCMF and NCTF). The information concerning the processes used for the manufacture of the different cheeses therefore did not significantly influence the WTP for the new cheeses.

Additional explanations revealed at step 4 and step 5, respectively leading to WTP-3 and WTP-4, significantly influence the WTP for both new cheeses (NCTF and NCMF). This same information had the opposite effect on the willingness to pay for the traditional cheese CC (significant decrease). Finally, the WTP values given for the three cheeses in complete information (WTP-4) were very close to each other, and the differences were not significant.

Fig. 8b and 8c show the evolution of the WTP for the two groups of consumers identified on the basis of the liking scores given during blind tasting. Graph 8b is very similar to graph 8a, which is not surprising since Group 1 represents 77% of the panel. However, a general increase in WTP for the new cheese NCTF can be seen for this group (Fig. 8b). The WTP of cheeses CC and NCTF did not differ after blind tasting and after information concerning the health and the environmental benefits of the new process (Fig. 8b, WTP-1, WTP-3 and WTP-4).

In contrast, Fig. 8c shows radically different behavior for consumers belonging to Group 2 (n = 33). Indeed, as shown in Fig. 7, these consumers did not like the new cheeses after blind tasting. This low taste rating was carried over into the WTP given after the blind tasting

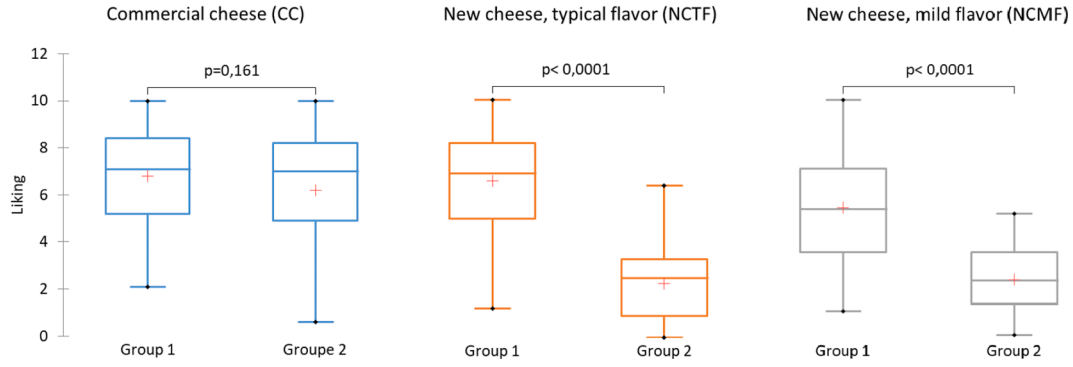


Fig. 7. Comparison of average liking scores for the two groups of consumers (two-sample *t* test, threshold set at 5%).

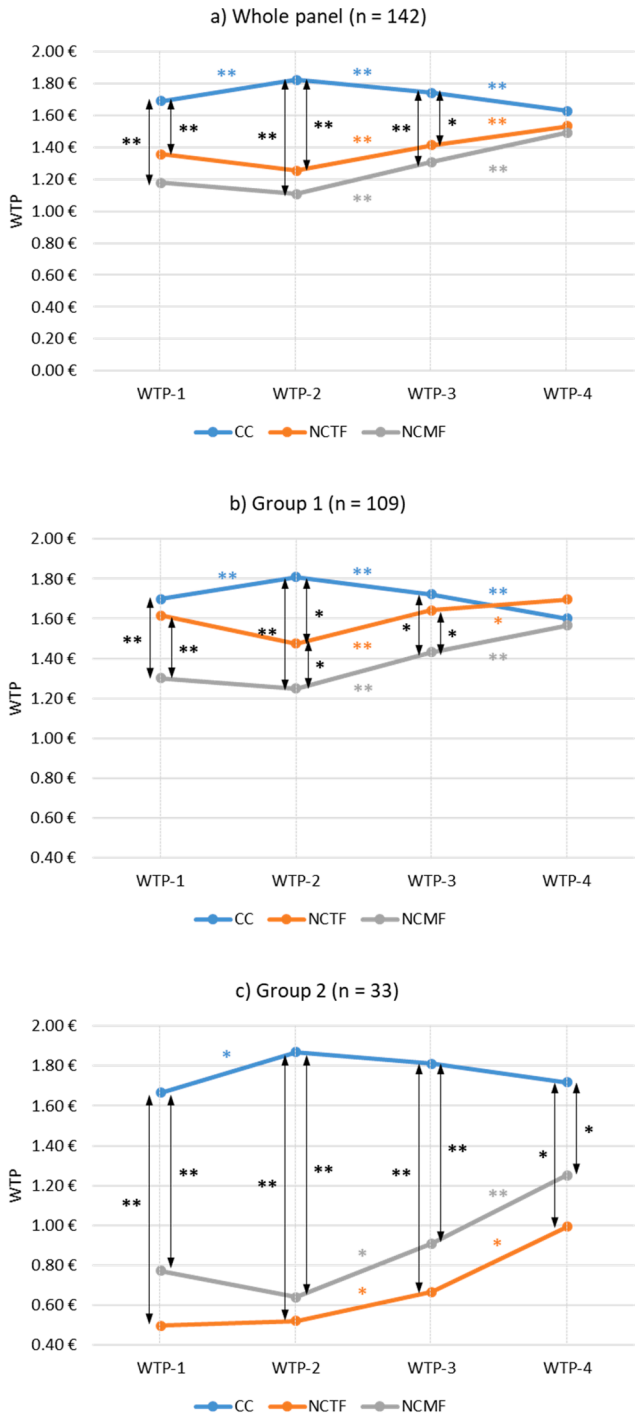


Fig. 8. Average WTP for 1 unit of cheese (250 g). Reminder: WTP-1 was elicited after blind testing, WTP-2 was elicited after information on the process, WTP-3 was elicited after information on the benefits of the new process for health (Group A) or the environment (Group B), and WTP-4 was elicited in the full information condition (benefits of the new process for health and the environment). Commercial cheese (CC), New cheese, typical flavor (NCTF), New cheese, mild flavor (NCMF).

(Fig. 8c, WTP-1). The revelation of the first information does not significantly change the WTP of the two new cheeses. However, we cannot exclude a side effect because WTP-1 was already very weak. On the other hand, the revelation of information concerning the benefits of the new process concerning health and the environment made it possible to upgrade the WTP of the two new cheeses (Fig. 8c, WTP-3 and WTP-4). However, this compensation was only partial because the WTP given for the two new cheeses with complete information was significantly lower than that of the traditional cheese (Fig. 8, WTP-4).

4.3. Impact of information concerning the new process and its benefits for health and the environment

Table 2 presents the results of the regressions (random effect Tobit model) carried out to study the impact of information concerning the benefits of the new process for health and the environment. This table presents the estimated coefficients for each of the variables taken into account in the regression model. For a given variable, the higher the coefficient, the more the corresponding factor had a positive impact on the WTP given with complete information (WTP-4). Conversely, the smaller the normalized coefficient, the more the corresponding variable had a negative impact on the WTP given with complete information (WTP-4). The p values associated with each coefficient specify whether the impact was significant or not, with a threshold set at 5% (*) or 1% (**).

The results of Model n°1 show that the three products significantly influence the WTP with complete information (WTP-4). The value of the coefficients associated with each of the three products (1.73, 0.95, and 0.52 for, respectively, the cheeses CC, NCTF, and NCMF) respects the hierarchy observed with the liking scores and the WTP given after the information about the processes was presented (Fig. 8a, WTP-2). In other words, the significant effect of the products observed by regression Model 1 is related to the appreciation of the sensory properties of the cheeses, after learning the process used to make cheese. The higher this coefficient, the more the cheese was positively evaluated. The results of Model n°1 also show that the effect of information about the health and environmental benefits of the new process did not have a significant impact on the traditional cheese (CC). These results seem inconsistent with the results of the Wilcoxon test used for comparing paired sample WTP and to measure the statistical significance of differences between WTP elicited for different products and different steps (Fig. 8a). Indeed, these tests showed that the two successive pieces of information had a significant negative impact on the WTP (Fig. 8a, cheese CC). However, in Table 2, the p value associated with the coefficient of the variable Cheese CC is close to the threshold of 5% (significant at 10%). Therefore, we cannot consider a real contradiction. On the other hand, according to Model n°1 and in agreement with the results presented in Fig. 8a, the information concerning the benefits of the new process had a significant positive impact on the WTP for the new cheeses NCTF and NCMF. The coefficients and the p value obtained for these two products (Table 2) suggest that the effect of the information was greater for the new cheese NCMF (coef. = 0.52) than for the new cheese NCTF (coef. = 0.36).

Model n°2 (Table 2) was designed to test the effect of the order of information regarding the health and environmental benefits of the new process. The results show that for the new cheese NCTF, the presentation of health information first had a significant positive impact on the WTP. For the new cheese NCMF, we also find this positive impact of the health-then-environment order but also a positive impact of the reverse order, even if the value of the coefficient is lower. These results are difficult to interpret, and we cannot conclude with certainty the effect of the order of the information concerning the benefits of the new process.

The results of regression Model n°3 show that the WTP for traditional cheese (CC) were, for both groups, positively and significantly influenced by the sensory properties of this cheese, after learning the process used for its manufacture. However, the informational messages did not have an impact, regardless of the consumer group (Table 3).

Table 3
Overall impact of health and environmental information on WTP, according to the two groups of consumers formed according to the liking scores for the three products: estimated coefficients (EC) coming from the regression (random effect Tobit model), p value associated with Student's t (test), and Standard errors (SE).

Independent variables (1/0)	WTP		
	Model n°3		
	EC[1]	p value[2]	SE
Cheese CC[3] × Group 1	1.71	**	(0.12)
Cheese CC[3] × Group 2	1.81	**	(0.14)
Cheese CC[3] × Messages × Group 1	−0.26		(0.16)
Cheese CC[3] × Messages × Group 2	−0.18		(0.29)
Cheese NCTF[4] × Group 1	1.28	**	(0.12)
Cheese NCTF[4] × Group 2	−0.27		(0.26)
Cheese NCTF[4] × Messages × Group 1	0.26		(0.18)
Cheese NCTF[4] × Messages × Group 2	0.85	*	(0.33)
Cheese NCMF[5] × Group 1	0.98	**	(0.13)
Cheese NCMF[5] × Group 2	0.03		(0.25)
Cheese NCMF[5] × Messages × Group 1	0.40	*	(0.16)
Cheese NCMF[5] × Messages × Group 2	0.95	**	(0.31)
Stand. devi ε (random effect of the estimator)	1.17	**	(0.03)
Stand. dev. μ [b] (tobit part of the estimator)	0.53	**	(0.06)
Observations	N = 852		
Log likelihood	−1245.1		

[1] Estimated coefficient or "-" (variable not used in the model).
[2] p value associated with Student's t: ** p value < 0.01; * p value < 0.05.
[3] CC: commercial cheese.
[4] NCTF: new cheese, typical flavor.
[5] NCMF: new cheese, mild flavor.

Table 4
Impact of variables on difference in WTP with a least square estimator: estimated coefficients (EC) coming from the regression (random effect Tobit model), p value associated with Student's t (test), and Standard errors (SE).

Independent variables	WTP			WTP		
	Model n°4			Model n°5		
	EC[1]	p value[2]	SE	EC[1]	p value[2]	SE
Cheese CC[3] (1/0) × Quality of food	–			0.10	*	(0.05)
Cheese CC[3] (1/0) × Positive attitude toward new foods	−0.25	**	(0.07)	–		
Cheese NCTF[4] (1/0) × Quality of food	–			−0.12	*	(0.05)
Cheese NCTF[4] (1/0) × Positive attitude toward new foods	0.33	**	(0.07)	–		
Cheese NCMF[5] (1/0) × Quality of food	–			−0.03		(0.05)
Cheese NCMF[5] (1/0) × Positive attitude toward new foods	0.45	**	(0.07)	–		
Observations	N = 426			N = 426		
Adjusted R^2	0.14			0.02		

[1] Estimated coefficient or "-" (variable not used in the model).
[2] p value associated with Student's t: ** p value < 0.01; * p value < 0.05.
[3] CC: commercial cheese.
[4] NCTF: new cheese, typical flavor.
[5] NCMF: new cheese, mild flavor.

The WTP given by the consumers belonging to Group 1 was positively influenced by the sensory properties of the three cheeses, after learning the process used for their manufacture. The coefficients concerning this group show that the hierarchy between the products, already observed in Model n°1, was preserved. For Group 1, the information concerning the benefits of the new process had a significant positive impact only for the new NCMF cheese. No effect was found for cheese NCTF (Table 3).

The WTP given by consumers belonging to Group 2 was significantly and positively influenced by the sensory properties of product CC, after learning its manufacturing process. This positive effect was not observed for the two new cheeses. However, the information concerning the benefits of the new process positively influenced the WTP given by this group of consumers for the two new cheeses (NCTF and NCMF). The coefficients presented in Table 3 show that this message was particularly effective for the new cheese NCMF.

Eventually, it should be noted that many sociodemographic variables were tested in alternative regressions. Only age significantly and negatively influences WTP, a variable not taken into account in Tables 2 and 3.

In Table 4, the two last regressions help us understand the influence of some perception about the shifts in WTP. A positive attitude toward new foods was positively related to the assimilation of information concerning the health and environmental benefits of the new process (Table 4, Model n°4). Moreover, attention to food quality was positively related to WTP for traditional cheese (CC) and negatively related to WTP for new cheese NCTF (Table 4, Model n°5).

5. Discussion

The results of this paper lead to several considerations that are now presented.

5.1. Liking and willingness to pay based on blind tasting

Preferences for foods result from complex interactions involving many factors, including sensory characteristics (Cardello, 2003). This is why the first step of this study was to evaluate blind tasting and the ranking of these three cheeses. The liking scores related to blind tasting indicates that consumers preferred the traditional cheese (CC). As shown in Tables 2 and 3, sensory properties (texture, flavor) are crucial for explaining the ranking among the WTP for the different products, eclipsing the sociodemographic variables that have no influence on these WTP (elicited on a hypothetical basis without real payment). The liking scores given after blind tasting made it possible to identify, among the 142 participants in this study, a small group of consumers (23% of the panel) who did not like the new cheeses. As the sensory properties were the only information available at this stage of the experience, it can be assumed that the consumers carried out a qualitative categorization on the basis of one or more sensory criteria. Based on the data collected, it is difficult to specify which specific sensory descriptors led this group of consumers to reject the new cheeses. Indeed, this group consists of only 33 people (23% of the panel). However, across the entire panel, the sensory characteristics at the origin of the lower acceptability of the new cheeses have been identified. These characteristics are presented in detail in Harel-Oger et al. 2022. Therefore, they will not be detailed in this document, we can still say that the main characteristics that have penalized the new cheeses are linked to the brevity of the ripening of the cheeses (too compact appearance and texture, lack of taste for NCMF cheese). We were aware that this very brief ripening would lead to atypical sensory characteristics compared to traditional cheese (CC). However, as the environmental efficiency of the new cheeses partly depends on this shorter ripening period, we wanted to test their acceptability with consumers. The visual and texture characteristics which have penalized the new cheeses can be improved by extending this ripening period. However, a compromise between the sensory and environmental aspects will have to be found. This point constitutes a working perspective. The fact remains that the situation was very interesting because it mimicked the case where products obtained with a new process appear on the market with a slightly different taste compared to the product universe in which they fit. This is an ideal case to study the possibility of compensating for a "sensory penalty" with information on the advantages of new products.

5.2. Reaction toward the new process

Consumers are willing to accept technological innovations in traditional products if the innovation is perceived as risk-free and if the product is not too distorted, in its image, in its quality with "pure" ingredients and/or in its taste (Braghieri et al., 2014; Lengard et al., 2011; Pilone et al., 2015). The integrity of food components is crucial for guaranteeing a relatively high WTP, a result previously verified with milk coming from cow or from plant-based substitutes such as soy or almond "milks" (Yokessa and Marette, 2019). This differs from studies focusing on WTP for genetically modified organisms or gene editing, in which messages on these technologies systematically lead to a sharp decline in WTP for specific foods (Lusk et al., 2005; Colson and Rousu, 2013; Lin et al., 2019; Caputo et al. 2020; Marette et al., 2021).

In the present study, it is interesting to note that the information concerning the processes used for the different products caused a significant increase in the WTP for the traditional cheese while the WTP for the two new cheeses did not change significantly. Thus, the reaction of consumers consisted of promoting traditional cheese without significantly penalizing the two new cheeses. Contrary to our hypothesis, the disclosure of the nature of the processes used did not have a negative impact on the WTP of the new cheeses. This shows that there is no significant opposition to the new process and that this information would not compromise the acceptability and the chances of success of cheeses obtained in this way.

It would be interesting to study the consequence of the initial level of consumer knowledge concerning cheese making. Indeed, we cannot rule out the possibility that reactions to information concerning the nature of the making processes used depend on this intial level of knowledge. This is an improvement that could be made in future studies.

5.3. Effect of information about the benefits of the new process for health and the environment

Our results show that the information concerning the benefits of the new process for health and the environment made it possible to valorize the new products, a result in line with several other works (Loebnitz and Bröring, 2015; Martin et al., 2021). Indeed, after revealing the two pieces of information, the WTP for the new cheeses was not significantly different from the WTP for the traditional cheese.

In the complete information condition (sensory properties, nature of the process, benefits linked to the new process), the level of overall appreciation was equivalent for the three products. This result is interesting because during blind tasting, the two new cheeses obtained mean liking scores that were significantly lower than the mean score for the commercial product. This difference, based on the intrinsic properties of the products (sensory properties), was −1.1 to −1.9 points on a scale of 10, depending on the new cheeses. The results obtained in this study therefore show that the extrinsic properties (benefits for health and the environment) highlighted using the two information messages made it possible to compensate for an initial hedonic difference of up to approximately 2 out of a scale of 10, which is not negligible. This positive assimilation shows that the appreciation of the new cheeses was sufficient; otherwise, it would not have taken place. Indeed, Saint-Eve et al. (2021) pointed out that the WTP for products with a low hedonic score did not change with the revelation of positive information, since the hedonic score was too low for having WTP being reversed with information.

In this study, a consumer group representing 23% of the panel did not like the taste of new cheeses or carried out a qualitative categorization to the detriment of the new cheeses on the basis of certain sensory criteria. However, even for these consumers, we have seen a positive assimilation of information about the benefits of the new process. It should be noted, however, that the valuation resulting from information concerning the benefits of the new process is only partial for these consumers. This confirms that sensory properties are an essential condition for good acceptability and that it is necessary to be very vigilant on this point.

It is interesting to note that in general, the valorization of WTP for new cheeses has been accompanied by a devaluation of WTP for traditional cheese, as if the advantages underlined for the new process had indirectly revealed the disadvantages of the traditional process. Indeed, one can assume that when highlighting the positive sides of the new process, consumers realized that in reality, the traditional process was not so healthy and/or respectful of the environment, or unless this process was perfectible.

The regression model designed to test the effect of the order of information regarding the health and environmental benefits of the new process showed that, for the new cheese NCTF, the presentation of health information first had a significant positive impact on the WTP given with complete information. For the new cheese NCMF, we also find this positive impact of the health-then-environment order but also a positive impact of the reverse order, even if the value of the coefficient is lower. One might assume that these results suggest that the health-environment order would favor the WTP given in complete information. However, the results concerning the new cheese NCMF are contradictory since they indicate that the two orders significantly favored the WTP with complete information (WTP-4). It is therefore difficult to conclude with certainty the effect of the order of the information concerning the benefits of the new process.

5.4. Study limitations and future research

The results obtained in this study are difficult to generalize to another type of innovation because it is likely that consumer reactions depend on the nature of the changes made by new technologies and the sensory modifications induced by these changes. However, this approach can be reused to test new scenarios.

6. Conclusion

Obtaining more sustainable food products sometimes involves making concessions in terms of sensory properties. The new process discussed in this study makes possible to obtain cheeses that are more respectful of the environment and whose nutritional composition is better for consumers' health. The revelation of the nature of the manufacturing processes (traditional or innovative) did not cause significant changes in the acceptability of new products. Consumers therefore seem open, at least to some extent, to innovation regarding traditional products such as cheese, particularly when basic ingredients are still "natural". Our results show that 77% of consumers positively assimilated the information concerning the benefits of new cheeses for both health and the environment. However, 23% of the panel was not receptive to this information. We have shown that the difference between these two groups resides, at least in part, in their initial appreciation of the products, based on sensory properties (blind testing). The variability in the reactions to information about health and environmental benefits of the new process was partly explained by sensory preferences. We can assume that, for the 23% of "insensitive" consumers, the sensory properties of the new cheeses were too different from their expectations to be completely convinced by the explanations of the advantages of the new process. The results of this study suggest that a communication based on virtues of the new process would be useful to increase the consumer acceptability of this type of cheese. This paper contributes to a better understanding of the factors determining the acceptability of innovations developed with the aim of improving the sustainability of traditional foods such as cheese.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence

the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgments

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References

Bieberstein, A., Roosen, J., Marette, S., Blanchemanche, S., & Vandermoere, F. (2013). Consumer Choices for Nano-Food and Nano-Packaging in France and Germany. *European Review of Agricultural Economics, 40*(1), 73–94. https://doi.org/10.1093/erae/jbr069

Braghieri, A., Girolami, A., Riviezzi, A. M., Piazzolla, N., & Napolitano, F. (2014). Liking of Traditional Cheese and Consumer Willingness to Pay. *Italian Journal of Animal Science, 13*(1), 3029. https://doi.org/10.4081/ijas.2014.3029

Caputo, V., Lusk, J., & Kilders, V. (2020). *Consumer Acceptance of Gene Edited Foods: A nationwide survey on US consumer beliefs, knowledge, understanding, and willingness to pay for gene-edited foods under different treatments*. FMI Foundation report, Washington D: C., USA.

Cardello, A. V. (2003). Consumer concerns and expectations about novel food processing technologies: Effects on product liking. *Appetite, 40*(3), 217–233. https://doi.org/10.1016/s0195-6663(03)00008-4

Cavallo, C., Carlucci, D., Carfora, V., Caso, D., Cicia, G., Clodoveo, M. L., … De Gennaro, B. (2020). Innovation in traditional foods: A laboratory experiment on consumers' acceptance of extra-virgin olive oil extracted through ultrasounds. *NJAS: Wageningen Journal of Life Sciences, 92*(1), 1–10. https://doi.org/10.1016/j.njas.2020.100336

Chamberland, J., Benoit, S., Harel-Oger, M., Pouliot, Y., Jeantet, R., & Garric, G. (2019). Comparing economic and environmental performance of three industrial cheesemaking processes through a predictive analysis. *Journal of Cleaner Production, 239*, Article 118046. https://doi.org/10.1016/j.jclepro.2019.118046

Colson, G., & Rousu, M. C. (2013). What do consumer surveys and experiments reveal and conceal about consumer preferences for genetically modified foods? *GM Crops & Food, 3*, 158–165. https://doi.org/10.4161/gmcr.26322

Dettori, A., Floris, M., & Dessì, C. (2020). Customer-perceived quality, innovation and tradition: Some empirical evidence. *The TQM Journal, 32*(6), 1467–1486. https://doi.org/10.1108/TQM-11-2019-0273

Frewer, L. J., Bergmann, K., Brennan, M., Lion, R., Meertens, R., Rowe, G., … Vereijken, C. (2011). Consumer response to novel agri-food technologies: Implications for predicting consumer acceptance of emerging food technologies. *Trends in Food Science & Technology, 22*(8), 442–456. https://doi.org/10.1016/j.tifs.2011.05.005

Garric, G., Leonil, J., Jeantet, R., Lortal, S., Schuck, P., & Gaucheron, F. (2016). Procédé pour la fabrication d'une denrée alimentaire fromagère, avantageusement du type fromage, spécialité fromagère ou substitut de fromage. *Patent*. WO2016108024.

Guiné, R. P. F., Florença, S. G., Barroca, M. J., & Anjos, O. (2020). The Link between the Consumer and the Innovations in Food Product Development. *Foods, 9*, 1317. https://doi.org/10.3390/foods9091317

Guiné, R. P. F., Florença, S. G., Barroca, M. J., & Anjos, O. (2021). The duality of innovation and food development versus purely traditional foods. *Trends in Food Science & Technology, 109*, 16–24. https://doi.org/10.1016/j.tifs.2021.01.010

Guerrero, L., Guàrdia, M. D., Xicola, J., Verbeke, W., Vanhonacker, F., Zakowska-Biemans, S., … Hersleth, M. (2009). Consumer-driven definition of traditional food products and innovation in traditional foods. *A qualitative cross-cultural study, Appetite, 52*(2), 345–354. https://doi.org/10.1016/j.appet.2008.11.008

Harel-Oger, M., Martin, C., Garric, G., Marette, S. (2022). A sustainable innovation leading to a tasty and healthy cheese. Working paper.

Hindsley, P. R., & Ashton Morgan, O. (2022). The Role of Cultural Worldviews in Willingness to Pay for Environmental Policy. *Environmental and Resource Economics, 81*, 243–269. https://doi.org/10.1007/s10640-021-00622-5

Lengard, A. V., Næs, T., Enderli, G., Sulmont-Rossé, C., Issanchou, S., & Hersleth, M. (2011). Consumers' acceptance of innovations in traditional cheese. A comparative study in France and Norway. *Appetite, 57*, 110–120. https://doi.org/10.1016/j.appet.2011.04.009

Lin, W., Ortega, D. L., Caputo, V., & Lusk, J. L. (2019). Personality traits and consumer acceptance of controversial food technology: A cross-country investigation of genetically modified animal products. *Food Quality and Preference, 76*, 10–19. https://doi.org/10.1016/j.foodqual.2019.03.007

Loebnitz, N., & Bröring, S. (2015). Consumer Acceptance of New Food Technologies for Different Product Categories: The Relative Importance of Experience versus Credence Attributes. *Journal of International Consumer Marketing, 27*(4), 307–317. https://doi.org/10.1080/08961530.2015.1022923

Lusk, J. L., Jamal, M., Kurlander, L., Roucan, M., & Taulman, L. (2005). A Meta-Analysis of Genetically Modified Food Valuation Studies. *Journal of Agricultural and Resource Economics, 30*(1), 28–44. https://www.jstor.org/stable/40987259.

Marette, S., Disdier, A.C., Beghin, J.C (2021). A Comparison of EU and US consumers' willingness to pay for gene-edited food: Evidence from apples. Appetite, Volume 159, April 2021, art. 105064, http://doi.org/10.1016/j.appet.2020.105064.

Martin, C., Lange, C., Marette, S. (2021). 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. Food Quality and Preference, Volume 87, art 104058, http://doi.org/10.1016/j.foodqual.2020.104058.

Pilone, V., De Lucia, C., Del Nobile, M. A., & Contò, F. (2015). Policy developments of consumer's acceptance of traditional products innovation: The case of environmental sustainability and shelf life extension of a PGI Italian cheese. *Trends in Food Science & Technology, 41*(1), 83–94. https://doi.org/10.1016/j.tifs.2014.09.005

Rabadán, A. (2021). Consumer Attitudes towards Technological Innovation in a Traditional Food Product: The Case of Wine. *Foods, 10*, 1363. https://doi.org/10.3390/foods10061363

Ronteltap, A., van Trijp, J. C. M., Renes, R. J., & Frewer, L. J. (2007). Consumer acceptance of technology-based food innovations: Lessons for the future of nutrigenomics. *Appetite, 49*(1), 1–17. https://doi.org/10.1016/j.appet.2007.02.002

Saint-Eve, A., Irlinger, F., Pénicaud, C., Souchon, I., & Marette, S. (2021). Consumer preferences for new fermented food products that mix animal and plant protein sources. *Food Quality and Preference. art, 104117*. https://doi.org/10.1016/j.foodqual.2020.104117

Siegrist, M., & Hartmann, C. (2020). Consumer acceptance of novel food technologies. *Nature Food., 1*, 543–1350. https://doi.org/10.1038/s43016-020-0094-x

Vanhonacker, F., Kühne, B., Gellynck, X., Guerrero, L., Hersleth, M., Verbeke, W. (2013). Innovations in traditional foods: Impact on perceived traditional character and consumer acceptance. Food Research International, 54, 2, 2013, 1828-1835, http://doi.org/10.1016/j.foodres.2013.10.027.

Yang, Y., & Hobbs, J. E. (2020). How do cultural worldviews shape food technology perceptions? Evidence from a discrete choice experiment. *Journal of Agricultural Economics, 71*(2), 465–492. https://doi.org/10.1111/1477-9552.12364

Yokessa, M., & Marette, S. (2019). A Tax Coming from the IPCC Carbon Prices Cannot Change Consumption: Evidence from an Experiment. *Sustainability, 11*(18), 4834. https://doi.org/10.3390/su11184834