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ORIGINAL ARTICLE

Sensory and Consumer Sciences

Impact of animal origin of milk, processing technology, type of product, and price on the Boursin cheese choice process: Insights of a discrete choice experiment and eye tracking

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Abstract: Boursin is a versatile semisoft cheese that can be made with different types of milk. While widely distributed in the European and North American markets, Boursin is produced to a limited extent in Brazil despite its commercial potential. This scenario encourages consumer-oriented product development studies by facilitating data collection with less bias and fewer product preconceptions, thus favoring the investigation of technological aspects of commercial interest. This study evaluates Brazilians' perceptions regarding different versions of Boursin cheese, with the aim of gaining a better understanding of the factors related to choosing cheese. Four attributes related to cheese production were evaluated at three different levels using two discrete choice experiments: one with eye tracking ($n = 20$) and another without ($n = 312$). These attributes included "type of processing" (evaluating pasteurization, ohmic heating, and preparation with raw milk), "animal origin of milk" (cow, goat, or buffalo milk), "type of product" (traditional, light, and lactose-free versions), and "price" (10.99, 13.99, and 16.99 BRL). Information regarding processing with ohmic heating did not affect the probability of Boursin being chosen, suggesting that consumers are open to using this emerging technology in Boursin cheese. However, information on being made with goat, buffalo, and raw milk negatively impacted the probability of choice, along with the price of 16.99 BRL. The frequency of cheese consumption and the level of health concerns also affected the probability of choosing the product.

KEYWORDS
consumer science, emerging technology, extrinsic factors, stated preference, visual tracking

Practical Application: Identifying the relationship between extrinsic attributes presented on the Boursin cheese label and the consumer's choice process can aid the communication process with the target audience and reveal how some technological issues of interest to manufacturers are perceived. This study indicates how information regarding the animal origin of the milk (cow, goat, and buffalo),

the type of processing (pasteurization, ohmic heating, and raw milk), the version of the product (traditional, light, and lactose-free), and the price affect the consumer choice process. The results provide insights that can be applied to product processing and designing labels.

1 | INTRODUCTION

The consumption of cheeses made with pasteurized bovine milk is predominant in Brazil. However, there has been an increase in the demand for goat and buffalo dairy products (Domenico et al., 2023; Guimarães et al., 2022), which could mean economic benefits when the country's productive potential is considered, in particular for goat milk (Braga Lobo, 2019). Additionally, when compared with bovine milk, goat milk has advantages, such as better digestibility and lower allergenic potential, and disadvantages, such as more intense sensory defects related to "stable-like," "animal-like," and "goat-like" flavors (Raynal-Ljutovac et al., 2011; Silva et al., 2015). Although such sensory defects have been minimized through advances in good manufacturing practices and handling hygiene (Park et al., 2017), products of goat origin remain more sensitive to heat treatment (Siefarth & Buettner, 2014).

Traditionally, cheeses are made with pasteurized milk, that is, milk subjected to heat (generally from 72 to 75°C for 15 to 30 s) to eliminate pathogens and reduce the microbial load. In Brazil, milk pasteurization is regulated by the Ministry of Agriculture, Livestock, and Supply through Normative Instruction 76 of 11/26/2018, which presents the Technical Regulation on the identity and quality of pasteurized milk (Brasil. Ministério da Agricultura, Pecuária e Abastecimento, 2018). However, in the dairy production chain, temperatures above 70°C are related to lipolysis, proteolysis, denaturation of proteins in the membrane of fat globules, and the exposure and activation of enzymes and amino acid residues (Lee & Sherbon, 2002). To address these issues, new technologies have been proposed to minimize the effect of processing on the sensory characteristics of dairy products.

Ohmic heating is an emerging technology that distinguishes itself because it produces dairy products with a lower content of free fatty acids compared with conventional pasteurization (Pereira et al., 2008). Additionally, there is less exposure of the food matrix to heat, which minimizes undesirable sensory changes (Rocha, Silva, et al., 2020), and lower energy expenditure, factors that make the technology promising for industrial use. Another manufacturing technique that has gained prominence is making cheeses with raw milk. That is, to produce cheese from milk without heat treatment to preserve the natural microbiota, with the practice being legalized in Brazil [Law No. 13.860 of 07/18/2019]. The legislation establishes strict criteria for producing and commercializing raw milk cheeses, demanding high-quality and high sanitary standards, including good agricultural and manufacturing practices, detailed inspection, microbiological tests, and traceability. However, there is a lack of information regarding how consumers perceive products made with non-bovine milk processed in ways other than the conventional means. In this scenario, investigating consumer perception and behaviors involved in food choice is an efficient way to develop industrially advantageous products that are aligned with the expectations of the target audience, ensuring more accurate communication and marketing actions (Bi et al., 2022; Grunert & van Trijp, 2014).

Different approaches have been used in studying food choice behavior, including online questionnaires, conjoint analysis, qualitative research, discrete choice experiments (DCEs), and monitoring of biometric signals such as eye tracking (Ares & Varela, 2018a, 2018b). The increased interest in monitoring ocular activity is due to the relationship between visual inspection, judgment, and decision making. One of the main interference pathways of visual attention in the perception process is to direct the open visual field to a specific point (stimulus), specifically the transfer of the visual stimulus to the fovea region of the retina. The fovea is known for its high density of sensory neurons and, consequently, greater capacity for specialized visual processing (Orquin & Mueller Loose, 2013).

Combining a DCE with eye tracking has produced promising results in research on consumer choice behavior (Balcombe et al., 2017; Dudinskaya et al., 2020; Edenbrandt et al., 2022; Kim et al., 2020; Uggeldahl et al., 2016). One of the advantages of a DCE is the evaluation of several attributes simultaneously, consistent with the theory of random utility and very similar to the actual purchase decision process (Güney & Giraldo, 2020). In general, a DCE assumes that consumers derive usefulness from the attributes of options available at the time of choice. Second, it is assumed that the preferences of individuals are revealed through their choices because a DCE allows an attribute value to be inferred in a declared choice model, even if the consumer is not fully aware of the value of this

attribute, reflecting factors related to the choice that are usually the result of habits, heuristics, and decisions of low involvement (Lizin et al., 2022).

In this context, the main objective of this study was to evaluate how Brazilian consumers perceive different versions of Boursin cheese, which vary concerning the animal origin of the milk (cow, goat, or buffalo), processing technology employed (pasteurization, ohmic heating, or manufacture with raw milk), product version (traditional, light, or lactose-free), and price. Finally, since some white, fresh, and creamy cheeses can be good sources of protein, vitamins, and minerals without being highly caloric and represent healthy sources for consumers, the influence of concerns regarding health in the consumer's choice was also evaluated.

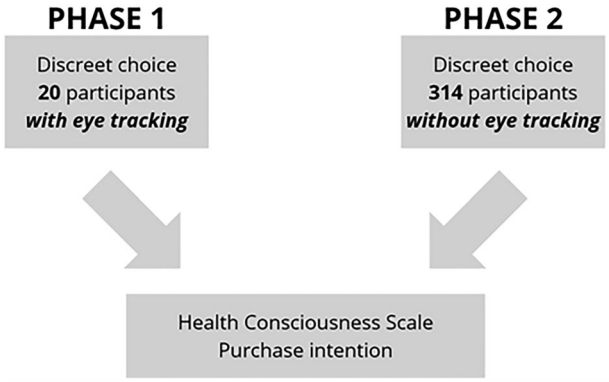

FIGURE 1 Data collection scheme.

2 | MATERIALS AND METHODS

2.1 | Data collection

The experiment was segmented into two phases, as proposed by Leon et al. (2020). Initially, the DCE was constructed as a digital questionnaire, which was completed by 20 subjects ($n = 20$), whose ocular activity was tracked. In the second phase, the same digital questionnaire was made available online and completed by 314 subjects ($n = 314$) who did not have their eye activity tracked. The groups used in the first and second phases were independent, that is, no participant from the first phase participated in the second. Given the number of factors involved in a DCE and the varying complexity of experiments (e.g., sampling vs. population inferences, binary or multinomial models, different designs), current sampling theory has not yet determined a totally adequate way to meet the requirements of sample size (Richetin et al., 2022). However, there is evidence that samples of 200 participants provide reliable results in a DCE (Richetin et al., 2022; Yang et al., 2015). Furthermore, Johnson et al. (2013) observed that accuracy increases rapidly when sample sizes approach 150 and then flattens at around 300 observations.

After the DCE, in both phases, the participants answered the questions on the Health Consciousness Scale (HCS) (Gould, 1990; Menon & Chavadi, 2022; Parashar et al., 2023) and a basic underlying preference questionnaire.

Participants for the DCE with eye-tracking were recruited on the campus of the Escola Superior de Propaganda e Marketing, utilizing a convenience sampling approach. In the DCE without eye-tracking, the participants were invited to take part through posters made available on social media. Thus, the sampling was of the snowball type and was obtained for convenience. The recruitment poster shared on social media stated that the study involved Boursin cheese and that any interested volunteers could participate in the research by accessing the link provided. The data collection stages are detailed in Figure 1. This research was approved by the Ethics Committee of the Federal Institute of Rio de Janeiro, under registration number 72095317.0.0000.5268.

2.2 | Discrete choice experiment

In a DCE, participants are presented with different alternatives (usually hypothetical products) and choose the ones that interest them most. In this study, pairs of Boursin cheese labels were presented to participants, who were asked to state which product they would choose or if they would not choose either of the two products presented. The labels were identical, except in the four "areas of interest" (AOI) under study, that is, in the four areas where the investigated attributes were displayed. Figure 2 presents some examples of the labels evaluated in this study. In DCEs, it is understood that the attributes of each sample can describe each choice made by the participant. Therefore, four attributes, with three levels each, were evaluated in this study (Table 1).

Considering the four attributes studied, with the three different levels of each, an orthogonal matrix was generated to obtain the experimental design. In this way, nine hypothetical products were generated (Table 2).

In both DCEs, nine slides with a pair of labels on each one were presented to the participants along with three choice options: "I prefer the product on the left," "I prefer the product on the right," or "Neither of the two products shown." On all the slides presented, the label on the right differed from the label on the left concerning the attributes under study. The presentation of products to participants followed the design of Table 2. Therefore, the first slide

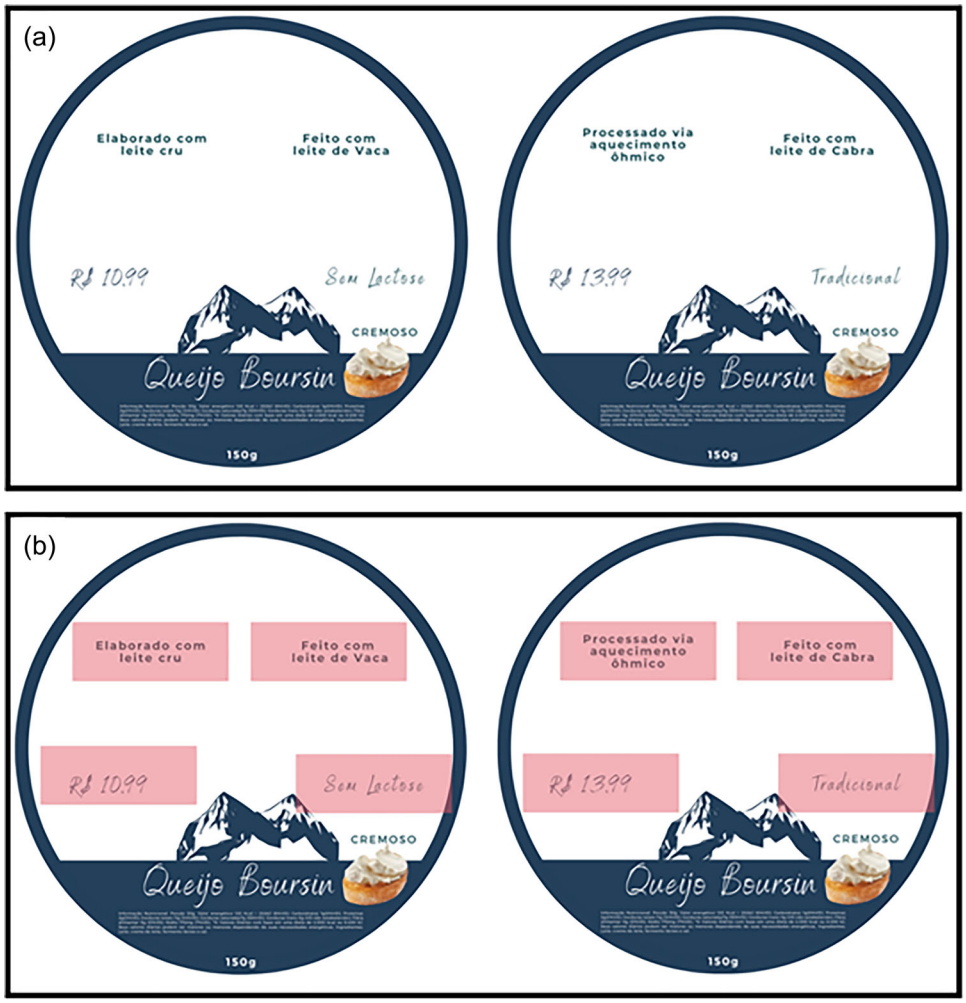

FIGURE 2 Examples of the evaluated Boursin cheese labels. (a) Original labels shown on discrete choice experiment (DCE). (b) In red the "areas of interest" where the evaluated attributes were shown.

TABLE 1 Definition of the attributes evaluated in the discrete choice experiment and their respective levels.

Animal origin of milk
Definition: Refers to the species of mammals that supply milk to the Brazilian cheese market and, therefore, the most familiar to consumers
Levels: "Made with Cow's Milk," "Made with Goat's Milk," and "Made with Buffalo Milk"
Processing technology
Definition: Refers to the technology used in cheese making
Levels: "Processed through pasteurization," "processed through ohmic heating," and "made with raw milk"
Product type
Definition: Refers to the main versions of the same cheese usually sold in Brazil, being familiar information during the inspection, judgment, and purchase of cheeses
Levels: "Traditional," "Light," and "Lactose-free"
Price
Definition: Refers to the continuous variable of the monetary value that the consumer is willing to pay for the product. The average price of Boursin-like cheese sold in Brazil (13.99 for 150 g) was taken as the central value, so a symmetric rate of 21.44% (R$3.00) was applied to obtain the high and low levels
Levels: "BRL 10.99," "BRL 13.99," and "BRL 16.99"

TABLE 2 Hypothetical products used in discrete choice.

Animal origin of milk	Processing technology	Product type	Price	Label
Made with cow's milk	Made with raw milk	Lactose free	10.99	1
Made with cow's milk	Processed through ohmic heating	Traditional	13.99	2
Made with goat's milk	Processed through pasteurization	Lactose free	13.99	3
Made with goat's milk	Processed through ohmic heating	Light	10.99	4
Made with goat's milk	Made with raw milk	Traditional	16.99	5
Made with buffalo milk	Processed through ohmic heating	Lactose free	16.99	6
Made with buffalo milk	Processed through pasteurization	Traditional	10.99	7
Made with cow's milk	Processed through pasteurization	Light	16.99	8
Made with buffalo milk	Made with raw milk	Light	13.99	9

presented labels 1 (left) and 2 (right). The second slide presented labels 2 (left) and 3 (right), and so on up to slide nine, which presented labels 9 (left) and 1 (right). In this way, it was ensured that all the labels were shown the same number of times in the two possible positions (right and left).

According to the theory of random utility (McFadden, 1973), discrete choice models or discrete choice modeling (DCM) can be applied based on the assumption that the utility of individual i in choosing alternatives j, in the situation of choice t (U_{ijt}), can be represented as

$$U_{ijt} = \beta_i' x_{ijt} + \varepsilon_{ijt} \quad (1)$$

where x_{ijt} is a vector of observed variables relative to individual alternative j and i; β'_i is a vector of structural parameters that characterize choices; ε_{ijt} is the unobserved error term, which is assumed to be independent of β and x.

Different random utility models can be derived by making different assumptions about the composition and distribution of the unobserved factors $f(\varepsilon_{ijt})$. In this study, the data collected from the DCE were analyzed with binary logit models instead of the error component random parameter logit (RPL-EC), as described in some works using DCM. For RPL-EC, it is necessary to have more than two choices for the individual (and not only two: choice and no choice, as is the case of this study).

All the participants in the experiment chose between different slides presenting the labels of Boursin cheese, indicating their choice (regardless of what label was) or non-choice. In this model, indicating a preference for either of the two products is considered a "choice," while not preferring either of the two products is considered a non-choice. The option "not to choose" given to consumers was considered to make the experiment more similar to a real choice experience (Van Loo et al., 2015).

Thus, two empirical models (logit) were estimated. Model 1 referred to data from experiment 1 (without using eye-tracking metrics), and model 2 used data from experiment 2 (using eye-tracking metrics), representing preference around population parameters and correlation between utilities (choice and non-choice).

The econometric analysis was performed using a logit model (binary logit model) to estimate the probability of an individual choosing the product according to the perceptions given by the explanatory variables used in each final adjusted model. In the binary logit model, the response given by individuals is a discontinuous and dichotomous variable. Therefore, if the individual answers YES to the question "Do you choose a product from this slide?", the dependent variable assumes a value of 1; if the answer is NO, this variable assumes a value of 0.

This model is based on the cumulative statistical probability function (logistics), given by

$$P_i = \frac{1}{1 + e^{-X_i\beta}} \quad (2)$$

where P_i represents the probability of occurrence of the product choice event, X_i is a vector of explanatory variables, and β is a vector of unknown parameters to be estimated. According to Rees and Maddala (1985), the parameters β_0, β_1, …, (β_n) are estimated from the dataset using the, in which a combination of coefficients is found that maximizes the probability that the sample has been observed. After estimating the logit model, the marginal effects (MgEs) of each attribute are calculated, finding the respective percentage in the variation in the individual's probability of choosing.

In nonlinear models, the estimated coefficient is not equivalent to the MgE of the dependent variable on the probability of the consumer making a choice, that is, $\partial P(Y = 1)/\partial X$ will not be directly β as in linear regression (Norton et al., 2019). Therefore, the analysis of the sign of the estimated coefficient is used as a qualitative indicator of the variable's direction. Thus, an estimated coefficient with a negative value indicates that increases in the value of this variable reduce the probability of the

product being chosen, whereas estimated coefficients with positive values indicate that increases in the value of this variable increase the probability of the product being chosen (i.e., the dependent variable taking on the value 1) (Leeper, 2021).

In this way, according to Rees and Maddala (1985), the MgE used in this study will not be the estimated coefficient of the explanatory variable, but instead:

$$\partial P\,(Y=1)/\partial X = \beta \frac{e^{-X_i\beta}}{\left(1+e^{-X_i\beta}\right)^2} \quad (3)$$

that is, by multiplying the estimated coefficient β of each explanatory variable with the density function of the logistic distribution. Consequently, the MgE was obtained through the partial derivative of the choice probability curve concerning the independent variable, keeping the values of the other independent variables constant. Therefore, the instantaneous rate of change of the probability curve at the point was obtained, equal to the tangent line's slope to the probability curve at that value. This tangent line is a linear approximation of the probability curve at the selected point. Thus, its value could be interpreted as the effect of changing 1 unit of the independent variable on the probability of choice (Glasgow, 2022).

Significance levels of 1% and 5% were adopted to ensure greater accuracy of the results (Leon et al., 2020).

The most robust models were selected by adopting criteria, such as the highest values of the pseudo-R^2, Akaike information criterion, and stepwise logistic regression (Hair et al., 2009). The percentage of agreement was obtained by calculating the ratio between the predicted values of the estimated model and the observed values in the data sample.

The software used to fit the model was the R Program (R Core Team, 2022).

2.3 | Eye tracking

The biometric analysis was performed with an eye tracker (Tobii T120) integrated into a 17′ monitor (update rate: 60 Hz, response time: 4 ms). This eye-tracking equipment can capture eye movements at 120 Hz (or every 8.3 ms), operate at a distance of 50–80 cm from the eyes, and follow head movements within 30 × 22 cm^2 (at 70 cm from the screen). In addition, inspecting AOI was used to collect and report data. This type of representation allows the generation of statistical data related to the participant's behavior in any stimulus area, relating visual fixation with the analyzed metrics. The main eye-tracking metrics used in this study can be seen in Table 3.

2.4 | Health consciousness scale

Consumers' food choice behavior is increasingly rationalized. As a result, individuals tend to reflect more on the food products they purchase (Hoffmann et al., 2020). In this scenario, information on ecological, environmental, and nutritional aspects is increasingly important (Bazzani et al., 2020). The HCS is a research instrument developed to investigate individuals' self-perception with regard to health-related aspects (Gould, 1990). In food science, the HCS indirectly gauges whether the individual's level of health concerns can affect their buying behavior. As originally proposed by Gould (1990), in this study, HCS data were collected using a seven-point Likert scale, ranging from "strongly agree" to "strongly disagree," to indicate the degree of consumer agreement with each HCS (Table 4) statement. Likert scales are intuitive and easily understood by consumers (Albaum, 1997). The statements used in the HCS are shown in Table 4.

Considering the congruent characteristic of the statements evaluated in the HCS and avoiding a high amount of derivation of categorical responses in the scale data, the arithmetic mean of the seven responses of each consumer was used, generating a numerical score ranging from 1 to 7 points for each respondent.

2.5 | Underlying preference

After completing the HCS, the participants were sent to the last page of the questionnaire to evaluate two statements related to underlying preference (Tanner et al., 2008). Given the congruent characteristic of the questions and to reduce the categories in the analysis, a score was calculated for each respondent, formed by the arithmetic mean of the two answers obtained regarding underlying preference. As it was based on a seven-point Likert scale, the score could range from 1 to 7. The scale's anchors ranged from "strongly agree" to "strongly disagree."

I really appreciated the Boursin Cheese

I would buy Boursin Cheese if it was on sale

2.6 | Variables used in the models

As already explained, the dependent variable adopted in this model had a binary structure and was assigned a value of "1" when one of the products was chosen and "0" when neither product was chosen.

TABLE 3 Metrics used in eye tracking.

Measure	Definition	Class
Fixation duration time	Duration of each fixation on each AOI	Time and position
Number of fixations in an area of interest (visits)	Number of times the participant inspects an AOI	Frequency and position

Abbreviation: AOI, areas of interest.
Source: Adapted from Duerrschmid and Danner (2018).

TABLE 4 Sentences evaluated in the "Health Consciousness Scale."

Sentence
"I reflect about my health a lot"
"I'm very self-conscious about my health"
"I'm usually aware of my health"
"I'm constantly examining my health"
"I'm alert to changes in my health"
"I'm frequently aware of my health status"
"I'm aware of the state of my health as I go through the day"

Source: Translated and adapted from Gould (1990).

The choice of reference levels (Determann et al., 2019; Mariel et al., 2021), that is, the levels of attributes that serve as points of comparison for the other categories, was deliberately made considering the representation of the status quo of marketed cheeses in Brazil. The "reference category" or "reference level" is the category used as the baseline for comparing all other categories of a categorical predictor variable. More precisely, the "reference level" can be considered the value usually observed for that categorical variable and that which will assume a value of zero in the calculation. Thus, the coefficients of the independent variables (non-references categories) indicate how changes in that variable toward the outcome category are in relation to the reference level.

Thus, for the attribute "animal origin of milk," we selected "made with cow's milk" as the reference level, representing Brazil's main type of milk that is consumed. Likewise, the "processed through pasteurization" attribute was chosen as the reference level for the "type of processing" attribute, as pasteurization is the predominant technology used by dairy manufacturers. "Traditional" was defined as the reference level for the "product version" attribute, due to the popularity of traditional products in the market and consumers' greater familiarity with them. As for the "price" attribute, the reference value was set at 13.99 BRL, representing the average price of semisolid cheeses (creamy and spreadable) sold in Brazil (for approximately 150 g).

The variables included in the DCE model without eye tracking are shown in Table 5, and those in the DCE model with eye tracking are in Table 6. Reducing the number of variables was necessary to maintain a good fit in the eye-tracking model due to the lower number of consumers and the inclusion of eye activity-specific variables. Thus, regarding the "processing technology" attribute, it was decided to retain the "processed through ohmic heating" information as an explanatory variable and the combination of "processed through pasteurization" and "made with raw milk" as reference level. This choice was motivated by the greater interest of this study in knowing the impact of information on ohmic heating, given the growth of industrial and academic interest in emerging technologies for dairy processing.

The "made with goat milk" information was also maintained as an explanatory variable due to the greater theoretical interest of this work in evaluating the perception of the Brazilian consumer with regard to goat cheese. This is motivated by the broad growth potential of Brazil's goat dairy market and the importance of knowing the factors that limit this growth. Finally, "light" was maintained as an explanatory variable while "traditional" and "lactose free" as reference level. Regarding the eye-tracking variables included in the analysis, the "time fixation duration" metric was used because it indicates how much time participants dedicate to fixing their eyes on an area of interest, revealing the perceived importance of a specific element or attribute. "Visit count" registers how many times the participants return to look at a certain area, indicating both the attractiveness and degree of involvement with the stimulus.

3 | RESULTS AND DISCUSSION

3.1 | General characteristics of the sample and models

A general sociodemographic description of the consumer sample can be seen in Table 7.

Regarding the estimated coefficients in both LOGIT models (Tables 8 and 9), it was observed that the signs found (positive or negative) were consistent with the theoretical hypotheses, suggesting the good adequacy of the model. More precisely, the initial hypotheses expected a reduction in the likelihood of consumers choosing versions

TABLE 5 Variables used in the discrete choice experiment model (without eye tracking).

Name	Definition
PAST[a]	Processed through pasteurization. Binary, value "1" when choosing a product processed through pasteurization and "0" for ohmic heating or raw milk
OHIM	Processed through ohmic heating. Binary, value "1" when choosing a product processed through ohmic heating and "0" for pasteurized or raw milk
RAW	Processed with raw milk. Binary, value "1" when choosing a product processed with raw milk and "0" for pasteurization or ohmic heating
COW[a]	Made with cow's milk. Binary, value "1" when choosing a product made with cow's milk and "0" when made with goat's or buffalo's milk
GOAT	Made with goat's milk. Binary, value "1" when choosing a product made with goat's milk and "0" when made with cow's or buffalo milk
BUFF	Made with buffalo milk. Binary, value "1" when choosing a product made with buffalo milk and "0" when made with cow's or goat's milk
TRANSL[a]	Traditional product. Binary, value "1" when choosing a traditional product and "0" when choosing a product without lactose or light
NLAC	Lactose-free product. Binary, value "1" when choosing a product without lactose and "0" when choosing one that is traditional or light
LIGH	Light product. Binary, value "1" when choosing a light product and "0" when choosing a product without lactose and light
P$16	Product value: 16 BRL. Binary, value "1" when choosing a product costing BRL 16.99 and "0" when choosing on that costs BRL 10.99 or BRL 13.99
YOUN[a]	Young consumer. Binary, value "1" when reporting age between 18 and 25 years or "0" when reporting another age
MATU	Mature consumer. Binary, value "1" when reporting age between 26 and 45 years or "0" when reporting another age
ELDE	Elderly consumer. Binary, value "1" when reporting age over 46 years or "0" when reporting another age
GEND	Consumer's gender. Binary, value "1" when reporting female biological sex and "0" when reporting male
MARI	Consumer's marital status. Binary, value "1" when reporting being married or in a stable union and "0" when reporting single, widowed, or separated
CONB	Cheese consumption. Binary, value "1" when the individual does not have the habit of consuming cheese and "0" when s/he consumes it regularly
HEAL	Average score on the Health Consciousness Scale (HCS). Continuous, represents the arithmetic mean of the grades given in the five sentences of the HCS
PURC	Grade average on purchase intent questions. Continuous represents the arithmetic mean of the grades assigned in the two sentences on underlying preference
CONT	Amount of cheese consumed. Binary, value 1 when the consumer reports consuming less than 30 g and "0" when consuming more than 30 g

[a]Categories defined as "reference level."

TABLE 6 Variables used in the discrete choice experiment model with eye tracking.

Name	Definition
OHIM	Processed through ohmic heating. Binary, value "1" when choosing a product processed through ohmic heating and "0" for pasteurized or raw milk
GOAT	Made with goat's milk. Binary, value "1" when choosing a product made with goat's milk and "0" when made with cow's or buffalo milk
LIGH	Light product. Binary, value "1" when choosing the light product and "0" when choosing one without lactose and light
STGO	Time fixation duration. To be continued. Total time that the consumer kept his/her eye fixed on the attribute "made with goat's milk"
STOH	Time fixation duration. To be continued. Total time that the consumer kept his/her eye fixed on the attribute "processed through ohmic heating"
INC1	Income range 1. Binary, value "1" when reporting income within the national average (2424.00–6060.00 BRL) or "0" when reporting another income
VCLA	Visit count. Discreet. Number of withdrawals or number of times the consumer inspects the "lactose-free" information

TABLE 7 General sociodemographic characterization of the consumer samples that participated in the discrete choice experiment with and without eye tracking.

Demographic descriptor	Proportion in the sample	
	DC (%)	DC + ET (%)
Gender		
Feminine	65.92	30
Masculine	33.45	70
Other	0.63	0
Age group (years)		
18–25	35.66	60
26–35	37.58	40
36–45	11.47	0
46–60	11.14	0
Over 60	4.15	0
Marital status		
Single	60.51	75
Married	24.20	25
Divorced	3.83	0
Widowed	0.64	0
Stable union	10.82	0
Income bracket		
(Minimum wages/month)		
Up to 1	10.83	0
2–5	51.27	45
6–10	17.84	40
Over 10	14.64	5
Did not inform	5.42	10

Abbreviations: DC, discrete choice; ET+DC, discrete choice and eye tracking.

of Boursin cheese with attributes other than those found in market-leading cheeses (i.e., cheeses made with pasteurized cow's milk in the traditional fashion). Additionally, regarding the fit of the LOGIT models, an agreement percentage of approximately 82.59% was observed for the general DCE (without eye tracking) and 90.50% for the DCE with eye tracking. Both models presented a good fit (Pino, 2007).

3.2 | Stated preference for Boursin cheese

The parameters used to interpret the impact of the explanatory variables evaluated in this study (Table 5) are shown in Table 8. More precisely, Table 8 shows the values associated with the estimated regression coefficient for each explanatory variable, its associated standard error, the *z*-value (coefficient divided by its standard error), the probability of observing a *z*-value as extreme as or more extreme than the observed one, and the MgEs.

In this way, regarding the "type of processing" attribute, it was observed that information on ohmic heating (OHMI) did not affect the probability of choosing Boursin cheese compared with the traditional pasteurized product (reference level). However, information about manufacturing with raw milk (RAW) reduced the probability of choosing the product by 9.1% compared with the traditional pasteurized product.

The fact that the statement "processed through ohmic heating" did not affect the probability of Boursin cheese being chosen is a particularly promising discovery, as it is not uncommon for consumers to reject emerging technologies that are typically less familiar. Deliza and Ares (2018) and Martins et al. (2022) observed that consumers are often surprised by the new technologies applied to food products because they perceive them as unfamiliar and possibly bad. In general, this is linked to a general lack of knowledge and to specific factors related to the particularity of the technologies themselves (dos Santos Rocha et al., 2022). Coutinho et al. (2021) noted that consumers of chocolate milk drinks considered the price an important factor for accepting a product processed by cold plasma. Hence, the purchase statement was due to the condition that the product processed by cold plasma was not more expensive than the traditional one. In relation to ohmic heating, there is a greater volume of literature addressing sensory changes and product acceptance, to the detriment of studies addressing consumer perceptions of the use of technology (Ángel-Rendón et al., 2020; Rocha et al., 2023; Rocha, Calvalcanti, et al., 2020; Silva et al., 2020).

Up to the time of writing, only the study by Coimbra et al. (2020) had addressed the presence of ohmic processing information (pasteurization vs. ohmic heating) among young consumers (about 80% aged 18–30) of whey dairy beverages, observing how this group of consumers positively perceived products processed via ohmic heating. The preliminary evidence observed in this study with Boursin cheese, as well as in the study by Coimbra et al. (2020), suggests that ohmic heating is not negatively perceived by consumers, even more so when considering other emerging methodologies. This initial evidence implies the favorable applicability of ohmic heating at an industrial level from the consumers' perspective, also suggesting that the presence of this information on labels can be positively exploited.

Continuing to evaluate the type of processing, it was observed that the information "made with raw milk" significantly reduced the probability of the cheese being chosen over the traditional pasteurized product (−9.1%). Colonna et al. (2011) observed that North American consumers feared the safety of cheeses made with raw milk, despite preferring them sensorially. Moreover, the authors observed that information on the safety of cheese made

TABLE 8 Estimates of the coefficients of the logit model and respective marginal effect values for discrete choice without eye tracking.

	Logit model				
	Coefficients	**Standard error**	***z* Value**	**Pr (>|z|)**	**Marginal effects**
Intercept	0.193	0.275	0.703	0.481777	–
OHMI	−0.181	0.125	−1.446	0.148094	−0.024
RAW	−0.638	0.123	−5.206	1.9e − 07***	−0.091
GOAT	−0.949	0.125	−7.609	2.8e − 14***	−0.140
BUFF	−0.566	0.128	−4.423	9.7e − 06***	−0.079
NLAC	−0.427	0.125	−3.433	0.0006***	−0.059
LIGH	−0.366	0.126	−2.902	0.004**	−0.050
P$16	−0.380	0.105	−3.623	0.0003***	−0.052
MATU	−0.203	0.125	−1.630	0.1031	−0.027
ELDE	−1.121	0.161	−6.952	3.6e − 13***	−0.187
GEND	0.197	0.105	1.876	0.0606	0.026
MARI	0.208	0.117	1.773	0.0761	0.026
CONB	3.152	0.752	−4.192	2.8e − 05***	0.154
HEAL	0.205	0.041	5.014	5.3e–06***	0.027
PURC	0.332	0.036	9.217	<2e − 16***	0.043
CONT	−0.390	0.100	−3.900	9.6e − 05***	−0.052

*** and ** indicate significance at 1% and 5%, respectively.

TABLE 9 Estimates of the coefficients of the logit model and respective marginal effect values for discrete choice with eye tracking.

	Logit model				
	Coefficients	**Standard error**	***z* Value**	**Pr (>|z|)**	**Marginal effects**
Intercept	4.72	0.94	4.99	5.9e − 07***	–
INC1	−1.93	0.70	−2.73	0.006**	−0.093
OHMI	0.64	1.34	0.47	0.632	0.022
GOAT	−3.13	1.33	−2.34	0.018*	−0.225
LIGH	−1.53	0.76	−2.0	0.045*	−0.074
STGO	0.58	0.26	2.20	0.027*	0.022
STOH	−0.01	0.23	−0.08	0.937	−0.0007
VCLA	−0.96	0.34	−2.82	0.004**	−0.037

*** and ** indicate significance at 1% and 5%, respectively.

with raw milk and its approval by the FDA increased perceived reliability and consumer choice. Unfortunately, ANVISA seals (equivalent to the FDA in Brazil) providing information on product safety are not commonplace in Brazil. However, future studies evaluating this strategy with dairy products processed with emerging technologies or made with raw milk may be of interest with regard to increasing the products' perceived reliability.

The investigation of the attribute "animal origin of milk" indicated that both the items of information, "made with goat's milk" (GOAT) and "made with buffalo milk" (BUFF), significantly reduced the probability of choosing Boursin cheese by 14% and 7.9%, respectively.

Consumers' rejection of goat's milk and its dairy products has been influenced by negative perceptions of the sensory characteristics of these products (Paskaš et al., 2020). When compared with other mammals, the stronger presence of undesirable sensory attributes in the milk of small ruminants is the main cause of greater rejection of the product. Therefore, it is not uncommon to find negative sensory descriptors such as "goat-like," "sheep-like," "stable-like," and "farmyard-like" in sensory tests involving dairy products from small ruminants (Raynal-Ljutovac et al., 2011). The short-chain fatty acids, usually containing 6–10 carbons (e.g., caproic, caprylic, and capric), branched-chain fatty acids (e.g., 4-methyl octanoic), cresol, and indole are identified as the main culprits for the undesirable aromas and milk flavors (Siefarth & Buettner, 2014). In general, good manufacturing practices and technological advances implemented in the milk processing chain

have drastically reduced the occurrence of sensory defects in marketed products. However, many consumers remain prejudiced toward dairy products of goat origin due to the greater intensity of sensory defects observed in these products in the past.

Information is lacking on how consumers perceive dairy products made with buffalo milk, especially more subjective information about perceptions, attitudes, and behaviors. However, in general, there is information from sensory analyses suggesting good acceptance of dairy products containing buffalo milk, such as Minas Frescal and semihard cheese for Brazilian consumers (Rekowsky et al., 2020, 2022) and Stracchino cheese for Italian consumers (Di Cairano et al., 2021). In addition, there is a greater added value in buffalo dairy products in Brazil, which favors its processing chain and has culminated in a smaller number of products with severe sensory defects compared with products sold that are derived from small ruminants (Azevedo et al., 2021). However, this study showed that, despite being more subtle, the information on products being made with buffalo milk also negatively affects (−7.9%) the probability of choosing Boursin cheese compared with the product made with bovine milk. This finding shows that Brazilian consumers continue to strongly favor traditionalism and prefer cheese made with bovine milk.

Cazacu et al. (2014) and Paskaš et al. (2020) suggested that the presence of health and well-being claims on the labels of these products can aid the acceptance of dairy products made with goat and buffalo milk. Thus, strategies to disseminate the qualities of products of non-bovine origin can improve the acceptance of these products in the market. The consumption of non-bovine dairy products, mainly goat, buffalo, and sheep, has increased due to the greater demand for products with different nutritional values, quality, and taste, in addition to the standard demand of consumers with gastrointestinal problems, allergies, and intolerance of dairy products made with cow's milk (Lopes et al., 2020). Even so, this increase has been slight due to individuals' previous and underlying negative perceptions.

The analysis of the "type of product" attribute showed a reduction of 5.9% in the probability of the lactose-free (NLAC) product being chosen, and a 5.0% reduction in the light (LIGH) product being chosen, in both cases over the traditional product. Although some consumers associate light and lactose-free products with benefits in terms of health and well-being, in this study, for Boursin-style cheese, the presence of this information indicated a reduction in the probability of the product being chosen, as specific audiences were unable to see past the standard associations of these products. The reduction of fat and the hydrolysis of lactose in cheeses are associated, for a large part of the market, with an audience with specific intake needs (allergic, intolerant, hypercholesterolemic, and arteriopathy). Therefore, it is common for light and lactose-free products to be less accepted than the regular version (Childs & Drake, 2009; Hartmann et al., 2018; McGuinness et al., 2022; Oliveira et al., 2017; Szakály et al., 2020).

The analysis of the "price" attribute indicated that the price of 16.99 BRL (P$16) reduced the probability of choosing Boursin cheese by 5.2% when compared with values of 10.99 and 13.99 (Table 8), suggesting that consumers have an idea of the average price of products in the category (150 g of cheeses from categories similar to Boursin cost an average of BRL 13.99) and that they are not willing to pay more for the product, despite it being new. Although it is possible for consumers to be willing to pay for food products that exceed the average selling price, this was not observed in the present study. Nutritional, ecological, and healthy appeals are generally related to consumers' greater willingness to pay (Bartels & Onwezen, 2014). In this study, the absence of such appeals on the labels may have influenced consumers' willingness to pay.

The analysis of variables related to the sociodemographic characteristics of consumers revealed that neither gender (GEND) nor marital status (MARI) influenced the likelihood of choosing Boursin cheese. Concerning age groups, it was observed that being aged between 26 and 45 years (MATU) had no significant impact on the probability of choosing Boursin cheese compared with young people aged between 18 and 25 (reference level in the analysis). However, it was found that those over the age of 46 (ELDE) were significantly less likely to choose Boursin cheese. An important systematic review involving dairy products (Bimbo et al., 2017) indicated that older consumers are more receptive to innovations compared with younger individuals, especially when it is stated on products that they provide nutritional and health benefits. There were no declarations related to nutritional and health advantages on the Boursin cheese labels, which might have adversely affected acceptance among older consumers.

Finally, regarding the habit of consumption (CONB), it was observed that the habit of not regularly consuming cheese increases the probability of choosing Boursin cheese by 15.4%, which suggests that sporadic and infrequent consumers are more open to choosing Boursin.

Regarding consumers' habit of consuming cheese, a certain traditionalism was observed among more regular consumers. The greater openness of sporadic consumers to the choice of Boursin-style cheese, compared with the regular cheese consumer, appears to be related to the greater trend of brand loyalty observed in heavy consumers (Sheth & Koschmann, 2019). As the Boursin cheese label evaluated in this study did not mention any real cheese brand, it is likely that this negatively impacted regular consumers,

as regular cheese consumers may be more loyal to the products they already consume and less receptive to new products and new brands (Arnade et al., 2008).

Health concern (HEAL), assessed through the mean intensity of responses to the five congruent questions on the HCS, indicated that increases in the intensity of concern for their health by consumers make them more likely to choose this cheese. Although not a low-fat cheese, Boursin is a white cheese resembling other soft white cheeses such as cottage cheese and ricotta cream. Thus, it is believed that the similarity between Boursin and low-fat cheese may have influenced the perception of individuals with greater health concerns.

Furthermore, the amount of cheese consumed (CONT) also affected the probability of choosing Boursin cheese. When consuming cheese, individuals who ate less than 30 g per day were less likely to choose Boursin cheese (−5.2%) compared with individuals who ate more than 30 g per day. Finally, it was possible to observe that increases in the mean scores for the questions related to the underlying preference (PURC) scale meant that there was a greater likelihood of Boursin cheese being chosen. Therefore, higher values reflect increases in the probability of choice by 4.3%, suggesting that strategies that improve the underlying perception of Boursin cheese can be useful in product communication, as their success can be directly converted into increasing the likelihood that the product will be chosen.

3.2.1 | Stated preference with monitored ocular activity

Like the general DCE (without eye-tracking), the coefficients showed signs corresponding to expectations and were significant at the 1% and 5% significance levels. The eye-tracking model ($n = 20$ consumers) included variables related to eye activity in addition to attribute-related variables (Table 6), and a reduction in the number of variables was required to maintain a good fit of the model due to the smaller number of consumers and the inclusion of specific ocular activity variables. The final model of the eye-tracking experiment is presented in Table 9, along with the values associated with the estimated regression coefficient for each explanatory variable, its associated standard error, the z value (coefficient divided by its standard error), the probability of noting a z value as extreme or more extreme than that observed, and the MgEs.

Therefore, regarding the "type of processing" attribute, it was observed that the "processed through ohmic heating" information did not significantly affect the probability of choosing Boursin cheese compared with the pasteurized product or one made with raw milk. This finding corroborates the general model (without eye tracking), strengthening the idea that ohmic heating is not negatively perceived by consumers, although it is an emerging technology. Furthermore, when evaluating the total fixation duration metric in the "processed through ohmic heating" (STOH) information, it was possible to verify that there was no significantly influential behavior regarding the choice of Boursin-style cheese. The relationship between total fixation duration on information and consumer behavior implies that longer fixation times may be related to a greater likelihood of choosing, and shorter fixation times are related to lower choice probabilities (van der Laan et al., 2015).

Regarding the "animal origin of milk" attribute, it was observed that although the information about goat milk (GOAT) production reduces the probability of choice (−22.5%), the probability of choosing the goat product increases when the consumer looks at the information for a longer time. Thus, it is indirectly inferred that consumers carry previous attitudes and perceptions concerning goat's milk, spending little time on inspecting and pondering the information. Furthermore, a greater gaze fixation on a given attribute has been strongly associated with a greater probability of choosing the product (Bialkova et al., 2020; van der Laan et al., 2015).

The model also included the number of visits (visual inspections) to the information regarding "lactose free" (VCLA) as an indicator of being less likely to choose Boursin cheese (−3.7%). More visits to the information that the product is "lactose free" reduced the probability of choosing Boursin-style cheese. Leon et al. (2020) noted that the number of draws was higher in products with attributes that were not in keeping with how the consumer thinks.

The main limitations of this study involved the type of sampling used (convenience sample) and the number of consumers in the eye-tracking experiment. Although the work with small groups involved in eye tracking is reliable, a larger number could have contributed more to clarifying the results. Furthermore, although popular in studies with consumers, the convenience sample did not allow us to make population claims, which would make the results even more impactful. In addition, the study did not gauge whether there were participants with lactose intolerance or who lived with someone who is lactose intolerant, which may have impacted the choice of Boursin cheese. However, in general, it is expected that the innovative character of this study for the research of extrinsic attributes can motivate further investigations in this respect to increase the body of evidence on Consumer-Driven Product Design.

4 | CONCLUSION

The attributes related to Boursin cheese were perceived differently by Brazilian consumers and impacted the probability of choosing the product at different levels. As for the animal origin of the milk, it can be seen that the traditionalism in favor of the product made with cow's milk persists, and, although Brazil has a great potential for the expansion of goat farming, the information that a product contained goat's milk was the aspect that exerted the greatest negative influence on the probability of choosing Boursin cheese. On the other hand, eye tracking indicated that consumers were subtly more likely to choose the goat product when willing to inspect the "made with goat's milk" information for a longer time.

The processing information study indicated that processing information with raw milk negatively affects the probability of choosing the product. In contrast, and surprisingly, processing information about ohmic heating does not affect the probability of choosing the product, suggesting the possibility of adopting this emergent method in cheese processing. The presence of information about ohmic heating on the label did not cause different behaviors in visual inspection, as observed in the eye-tracking metrics. The neutrality in the eye-tracking metrics indicates the non-rejection of the emergent processing technique compared with traditional pasteurization.

Regarding the type of product, both the "light" and "lactose-free" product information reduced the probability of choosing Boursin cheese when compared with the "traditional" product information. Furthermore, the higher frequency of visual visits to the "lactose-free" information indicated behavior that negatively affected the choice of Boursin cheese.

In addition to the attributes directly related to the product, it was observed that occasional consumers of cheese and those who consume no more than 30 g per day are more likely to choose the product, corroborating the idea that heavy and regular consumers tend to be more loyal to brands and the products they already consume. In this way, communication and marketing strategies can be directed toward less frequent consumers, seeking to explore the greater probability of them choosing a new product on the market, such as Boursin cheese. Additionally, more health-conscious individuals were more likely to choose Boursin-style cheese.

AUTHOR CONTRIBUTIONS

Elson R. Tavares-Filho: Conceptualization; methodology; data curation; investigation; formal analysis; writing—original draft; software; visualization. **Luiz G. S. Hidalgo**: Methodology; software; investigation. **Lilian M. Lima**: Methodology; software; data curation; investigation; validation; formal analysis; visualization. **Eduardo E. Spers**: Conceptualization; methodology; data curation; supervision. **Tatiana C. Pimentel**: Investigation; validation; writing—original draft; visualization. **Erick A. Esmerino**: Conceptualization; methodology; software; data curation; investigation; formal analysis; writing—original draft. **Adriano G. Cruz**: Conceptualization; resources; supervision; project administration; funding acquisition; investigation; methodology.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that may have appeared to influence the work reported in this paper.

DATA AVAILABILITY STATEMENT

Data will be made available on request.

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