



## ORIGINAL ARTICLE

# Consumers' Sensory Profile and Understanding of Clean-Label Sausage. An Approach Using Ultra-Flash Profile and Check-All-That-Apply

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## ABSTRACT

Clean-label meat products are trending in the food industry; however, they are little known by consumers. In this context, the present work aims to: (i) assess the sensory characteristics of fresh sausage supplemented with natural additives through the application of ultra-flash profile (UFP) and (ii) investigate consumers' knowledge of clean-label meat products using check-all-that-apply (CATA) questions. Fresh sausage formulations were prepared from different concentrations of celery and rosemary extracts with curry. The results showed that different concentrations of these natural additives corresponded to different sensory profiles. The attributes that most effectively distinguish sausages are their red color, flavorful seasoning, juiciness, and spiciness. The results from CATA questions indicate a lack of understanding regarding chemicals and additives in food, as well as about clean-label. Clean-label meat sausage appears promising as consumers place a high value on natural additives. The remaining challenge for the meat industry's marketing sector is to establish a connection between natural additives and clean-label products in the minds of consumers.

## 1 | Introduction

The development of food products with the exclusive use of natural ingredients is a trend in the food sector (Hsu et al. 2023; Jamaluddin et al. 2022). However, in Brazil, clean-label products are rarely found on supermarket shelves (Sbardelotto et al. 2022) and this situation is no different for the meat products sector. Even though Brazil stands out on the world meat scene, reaching an important position as a producer, consumer, and exporter of beef, poultry, and pork (Hötzel and Vandresen 2022), there is still significant potential for growth in the clean-label meat products sector.

The term clean-label is increasingly being used in different products and appears more frequently in the literature in recent years; however, there is no common definition determined for its use, which creates a lack of information among the population (Asioli et al. 2017). One of the objectives of the name "clean-label" is the creation or reformulation of foods, describing the product with ingredients that are known, simple, and familiar to the consumer, leaving aside technical terms that are difficult to understand and that give the impression of being artificial, less safe, and unhealthy (ANVISA 2020).

Industries in the meat sausage sector have been seeking to innovate in this market. Fresh sausage is a popular meat product

## Summary

- Brazil is a large producer, exporter, and consumer of meat products, with fresh sausage being among the most popular.
- The use of natural additives for food product development is of growing interest to both consumers and industry.
- Understanding the effect of natural additives on new formulations and the importance given by consumers to foods that are developed in a healthy way is an important step in the development of clean-label products.
- UFP and CATA methodologies proved to be important tools to define sensory profiles and explore consumers' knowledge of clean-label sausage.

in Brazil among the different classes of meat sausage (Beck et al. 2021; Mürmann et al. 2009; de Oliveira et al. 2020; Rossi et al. 2011). It is made from a blend of ground pork and/or ground chicken, curing salts, antioxidants, spices, coloring agents, a variety of additives, and then encased in a natural or artificial casing (Beck et al. 2021). The function of curing salts is related to improved color, flavor, lipid oxidation, and most importantly: bacteriostatic and bactericidal function against pathogenic bacteria (Alahakoon et al. 2015; Zhang et al. 2023). This last function makes the use of nitrates/nitrites in meat products mandatory under Brazilian legislation. Additionally, as mentioned by Zhang et al. (2023) the multiple functions of nitrite in meat and meat products cannot be fully replaced by other food additives at present, which makes this additive a valuable ingredient. There are concerns about their quality and safety due to the formation of carcinogenic compounds N-nitroso in processed meats, and for that reason, it has had a serious negative impact on the meat industry. Synthetic antioxidants have also been identified as toxicological and/or carcinogenic (Kumar et al. 2015).

Consumer awareness of food additives has been documented in previous studies (Aoki et al. 2010; Mitterer-Daltoé et al. 2021), and it has been noted that consumers express concerns regarding meat products (de Araújo et al. 2022; Teixeira and Rodrigues 2021). de Araújo et al. (2022) highlighted the presence of chemical additives as a severe concern for meat products. Therefore, studies considering new technologies are being conducted in order to find alternatives that can replace the functionalities of synthetic additives (Aksu et al. 2022; Zhang et al. 2023; Zhou et al. 2020).

The use of plant extracts as a natural source for these compounds is an example of sustainable and natural alternatives (Alahakoon et al. 2015; Cömert and Gökmen 2018; Oliveira et al. 2023; Zhang et al. 2023). Celery has enormous potential to be used as a natural source of nitrate in the meat industry (Flores and Toldrá 2021), as it has little pigmentation and has a mild flavor, with a low effect on the sensory characteristics of meat products (Alahakoon et al. 2015), and, therefore, a low effect on consumer perception. Rosemary is one of the most used natural antioxidants in the food industry (Oswell et al. 2018), while curry is a source of bioactive compounds that have antioxidant and antimicrobial action (Biswas et al. 2012). (Demarco et al. 2022) reported that rosemary

extract with curry was more effective than the synthetic antioxidant in inhibiting lipid oxidation of sliced salami, increasing the shelf life of the meat product by 30 days.

It turns out that these natural ingredients, the vast majority of which come from plant sources (Oliveira et al. 2023), often present some type of limit or difficulty in their use in the food sector. Limits that may be related can influence appearance, flavor, and stability (Ares et al. 2009; Bordim et al. 2021; Carochio et al. 2018; Ohtaki et al. 2023). Therefore, carrying out application and consumer perception studies in terms of sensory profile and knowledge about food additives and clean-label meat products is of fundamental importance.

Knowing that Brazil is a large producer, exporter, and consumer of meat and meat products; and that natural additives are a core topic of food science and valued by consumers, but that clean-label is an unknown term for them, the present work aims to: (i) evaluate the sensory profile of fresh sausage with natural additives added and (ii) explore consumers' knowledge of clean-label meat products.

## 2 | Material and Methods

### 2.1 | Elaboration of Fresh Sausage With Natural Additive Added

Six fresh sausage formulations were prepared: control formulation (FC), with synthetic preservatives and antioxidants, being sodium nitrite (0.015%) and antioxidant (0.42%); F1 with the addition of celery extract (0.1%) and rosemary extract with curry (0.01%); F2 with celery extract (0.14%) and rosemary extract with curry (0.01%); F3 with celery extract (0.1%) and rosemary extract with curry (0.026%); F4 with celery extract (0.14%) and rosemary extract with curry (0.026%) and F5 with celery extract (0.12%) and rosemary extract with curry (0.018%). Twenty-seven kilograms were prepared per formulation. Fresh ham (80%) and pork belly (20%), cooled to 4°C, were ground in a grinder (MADO GmbH), using a 12mm disc. Afterward, they were manually mixed with water (5%), salt, and spices (3.85%) and beetroot coloring (0.2%). The paste was reserved for 12h at a temperature of 4°C, and then embedded (Handtmann VF 610 Plus, Germany) in previously hydrated natural pork casing. The fresh sausage formulations were vacuum packed and stored at a temperature of 2°C. To sensory analyze, the fresh sausages were cooked on an electric grill (Fisher, Mod. 1323-5697) until reaching an internal temperature of 72°C. After removing the ends, the sausages were served in pieces of 16g at a temperature of 60°C (Honrado et al. 2022). The samples were served to each participant on plates with three-digit codes in a random order. All participants were given toothpicks, a paper napkin, and a glass of water.

### 2.2 | Ultra-Flash Profile and Frequency of Fresh Sausage Consumption

Ultra-flash profile was applied to 27 consumers (14 women, 13 men), aged between 21 and 56 years old. The methodology followed the procedure used by (Delarue 2014). UFP sessions were individual and took place in sensory booths. Consumers were asked to observe, smell, taste, and describe using their own

descriptive terms, excluding non-hedonic attributes in order to rank the fresh sausage samples on an unstructured scale of 9 cm based only on the two extremes, using the terms “weak” and “strong” in accordance with their intensity. The fresh sausage samples were presented simultaneously to allow a direct comparative evaluation, which makes the quantification easier.

“How frequently do you consume fresh sausage?” was asked of the participants and measured on an 8-point scale: (8) more than once a day- (7) daily- (6) several times a week- (5) weekly- (4) several times a month- (3) monthly- (2) less than monthly- (1) never.

Participants were invited via e-mail from a database. An informed consent form at the beginning of the questionnaire was provided. The inclusion criteria were consumers of fresh sausages aged between 18 and 60 years. The exclusion criteria were allergens to the components of the sausage formulation. The Ethics Committee for Human Research of the Federal University of Technology-Paraná approved the study (CAAE number 50340021.7.0000.0177).

### 2.3 | Check-All-That-Apply Questions and Frequency of Meat Sausage Consumption

A CATA questionnaire containing statements was presented to 200 participants to assess their knowledge, interest, and sensory attributes preferences for clean-label meat products. Of the participants, 117 were female and 83 male; 23% aged 18–30, 53.5% aged 31–50, and 23.5% aged more than 50. The majority had at least post-high school (67%); 26% had high school, and 6.5% had pre-high school. Participants were recruited via e-mail, social media, and smartphone communication apps. An informed consent form at the beginning of the questionnaire was provided. Only adults (aged  $\geq 18$ ) who make independent food choice decisions were allowed to participate. The Ethics Committee for Human Research of the Federal University of Technology-Paraná approved the study (CAAE number 50340021.7.0000.0177). The CATA questionnaire was handled using the Google Forms tool.

For each statement, an opposite sentence was presented to obtain reliable results. Participants who marked the statement and its opposite were eliminated. The sentences were presented in a randomized way (Meyners and Castura 2014). Participants were instructed: “From the following list, check the sentences you are in accordance with.”

The CATA sentences were based on a theoretical background of literature and the terminologies that emerged from UFP. Questions about natural additives and health followed findings from previous studies (Bordim et al. 2021; Mitterer-Daltoé et al. 2021). In both studies, consumers showed an awareness of the health aspects and food safety of natural food additives. The studies explored consumers’ understanding of additives in foods and highlighted the lack of knowledge about the subject (Dickson-Spillmann et al. 2011; Shim et al. 2011; Varela and Fiszman 2013). The sentence about willingness to pay for natural additives added to meat products followed the results shown by studies that investigated if consumers are willing to pay a premium for food products endowed with sustainability labels

(Tebbe and Blanckenburg 2018). Questions about meat sausage appearance were created based on the UFP terminologies. The sentences explored the importance of color in meat sausages and the presence of visible seasonings and fat.

### 2.4 | Data Analysis

The UFP and CATA questions were analyzed using XLSTAT software (Addinsoft) and Statistica 12.7. UFP data were analyzed by generalized Procrustes (GPA). The interpretation of the sample description was obtained by joint analysis of the GPA biplot and the correlations between the first two dimensions for each consumer (Martins et al. 2020). Analysis of the CATA data was performed by Cochran’s Q test carried out among all statements with a 5% significance level ( $\alpha = 0.05$ ) (Godoy et al. 2019). To better understand and visualize the relationship between CATA sentences and demographic traits, correspondence analysis (CA) was applied (Bordim et al. 2021). Scholasticity was divided into three groups: Primary (pre-high school), Secondary (high school), and Tertiary (post-high school). The groups of age and gender followed the combinations: Female/18–30 years old; Female/31–50 years old; Female/> 50 years old; Male/18–30 years old; Male/31–50 years old; and Male/> 50 years old.

## 3 | Results

### 3.1 | Frequency of Consumption and Terminology Compiled to Describe Fresh Sausage With Natural Additives Added

Figure 1 shows the frequency of fresh sausage consumption from ultra-flash profile participants. Results revealed that 71.42% of participants consumed fresh sausages between weekly and several times a month. These values align with the data reported by the Brazilian Institute for Geography and Statistics (IBGE 2020), in which they emphasize the high consumption of fresh sausage, accounting for 33.2% of the total consumption of processed meats among Brazilians. This high consumption can be attributed to the convenience of a readily prepared product (de Oliveira et al. 2020), affordability (Beck et al. 2021) and culture (Mürmann et al. 2009; Rossi et al. 2011) linked to the Gaúcho culture and its tradition of barbecue (*churrasco*) consumption.

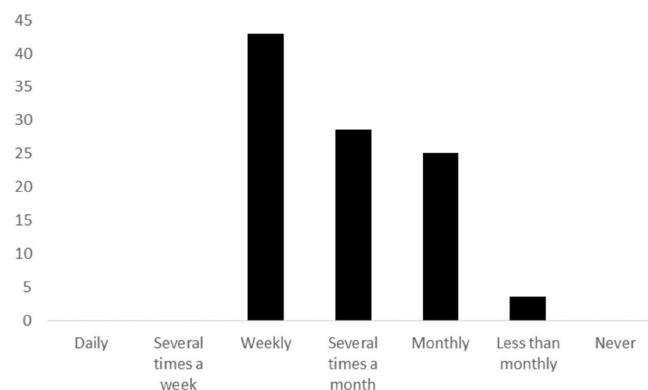


FIGURE 1 | Frequency of consumption (%) of fresh sausage of ultra-flash profile participants.

Figure 2 shows the frequency of occurrence of sensory descriptors for the characterization of fresh sausage. A total of 15 attributes was generated, a number very close to that recorded by (Santos et al. 2013) ( $n=16$ ), who used an ultra-flash profile to describe mortadella. Eight attributes, which involved the characteristics of appearance, flavor, and texture, were cited by at least 5% of the participants. In descending order: red color, characteristic flavor, seasoning flavor, visible fat, firmness, saltiness, tenderness, and greasy flavor were the most-cited attributes to describe the fresh sausage.

### 3.2 | Sensory Profile of Clean-Label Fresh Sausage Formulations

According to Husson et al. (2001), one of the essential qualities of sensory profiles obtained from consumers is the consensus.

However, for flash profiling or ultra-flash profiling, due to the nature of the method (consumers do not evaluate the same attributes), consensus is not pertinent (Delarue 2014). Despite this important observation, GPA gives residuals of each consumer (Figure 3) and residuals by samples (Figure 4). Results revealed low consensus among consumers in ranking the samples.

For flash profiling, the analysis of the multidimensional results together with attributes best correlated with the dimensions 1 and 2 per assessor allows better visualization and comprehension of the perception of consumers regarding the fresh sausage. The first two GPA dimensions accounted for 69.36% of the variance (Figure 5a). The first dimension separated F1 and FC from F2, F3, F4, and F5. The second dimension separated F4 and F5 from the others. Results from GPA revealed that the different formulations could be distinguished by the ultra-flash

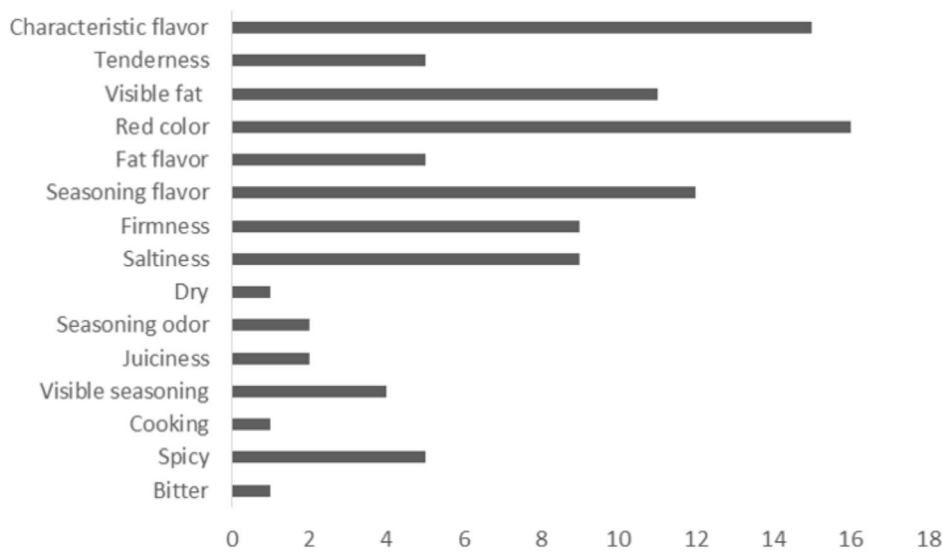


FIGURE 2 | Frequency of occurrence of sensory descriptors for the characterization of fresh sausage.

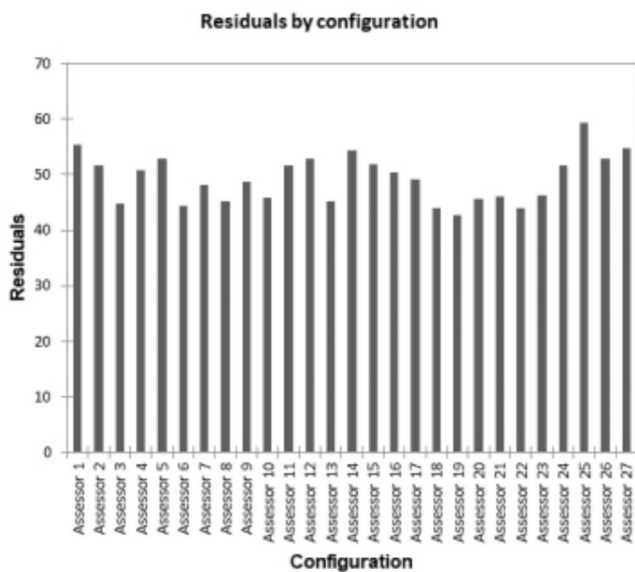


FIGURE 3 | Residuals by consumer (configuration) after the transformation by GPA.

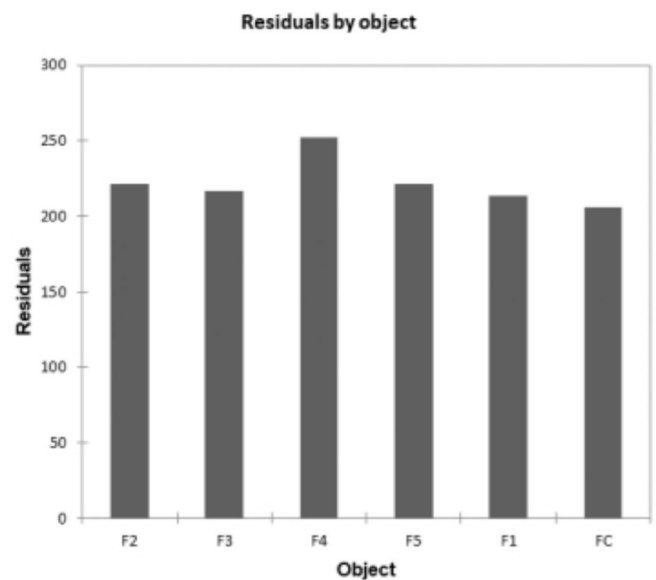


FIGURE 4 | Residuals by object after the transformation by GPA.



**TABLE 1** | Attributes best correlated with the dimensions 1 (F1) and 2 (F2) of GPA biplots (Figure 5) per assessor ( $r > 0.60$ ).

Assessors	F1	F2
A1	0.73 characteristic flavor	
A2	0.69 tenderness; 0.72 visible fat	−0.63 seasoning flavor
A3	0.81 red color; −0.72 visible fat; 0.74 fat flavor; 0.93 seasoning flavor	0.68 visible fat; −0.72 tenderness; −0.75 cooking
A4	0.86 red color	0.83 fat flavor
A5	−0.64 characteristic flavor	0.68 spicy
A6	0.75 seasoning flavor; −0.72 firmness	
A7	0.67 saltiness; 0.69 seasoning flavor; −0.74 characteristic flavor; 0.71 spicy; 0.78 firmness	−0.84 red color
A8	0.72 saltiness; 0.84 red color	
A9	0.79 characteristic flavor; 0.81 seasoning	
A10	0.68 red color; 0.91 seasoning flavor; 0.81 firmness	0.75 spicy
A11		0.96 spicy
A12		0.97 saltiness; 0.93 characteristic flavor
A13	0.76 firmness	0.77 characteristic flavor
A14	0.6 red color	
A15	0.78 red color	
A16	0.62 red color	−0.68 visible seasoning; −0.78 fat flavor; −0.73 juiciness
A17		0.80 visible fat
A18	0.86 seasoning odor; 0.95 characteristic flavor	0.61 juiciness
A19	0.77 red color; 0.76 characteristic odor; 0.92 red color	
A20	0.89 seasoning flavor; 0.76 red color	−0.68 juiciness
A21	−0.92 saltiness; 0.71 tenderness	
A22	0.96 red color; 0.60 visible fat	−0.61 visible seasoning
A23	−0.72 firmness; 0.76 red color	−0.79 saltiness
A24	0.79 characteristic flavor	−0.77 firmness
A25	—	—
A26		0.72 saltiness; 0.68 dryness
A27	0.61 visible fat	

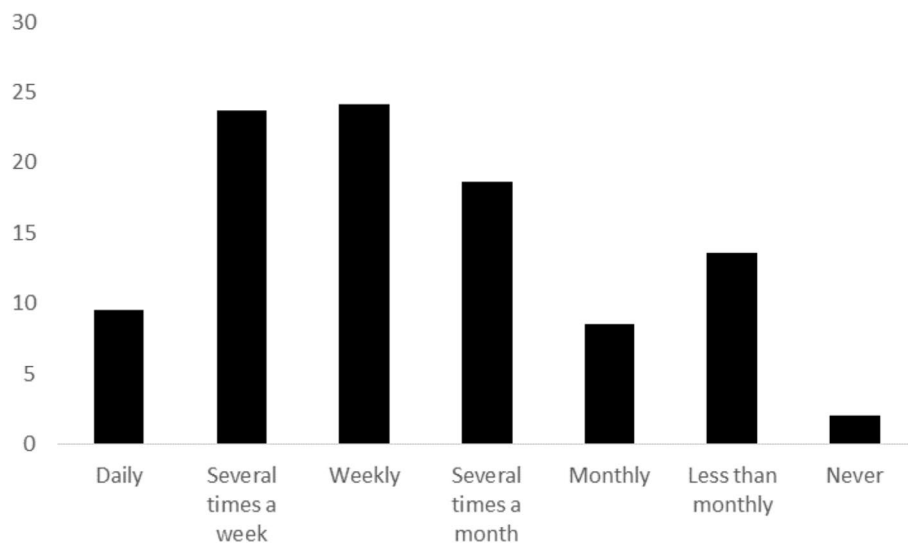
Consumers answered the CATA questionnaire that contained sentences designed to explore consumers' understanding and perception of clean-labels, food additives, and sausage attributes of appearance, in addition to their willingness to pay extra for sausage made with natural additives. Table 2 shows the percentage of participants who marked each statement. Significant differences between statements were also obtained by Cochran's Q test.

The statements most cited indicated that the majority of consumers understand that natural additives are healthier than synthetic ones, and that color and visible fat are important attributes for meat sausage. It was interesting to note that although 62.9% stated that natural additives are healthier than synthetic ones, 51.2% of respondents stated that they have no knowledge about

clean-label meat foods. This fact indicated that the term clean-label may not be widely recognized by meat sausage consumers, but the concept of healthiness is gradually gaining awareness among them. The fact that 60.4% of respondents expressed their willingness to pay extra for meat sausage made with natural additives underscores the market potential of these food categories.

### 3.2.2 | The Role of Sociodemographic Factors in the Consumers' Understanding and Perception of Meat Sausage

Combining the sentences of the CATA questions and the frequency of consumption and sociodemographic traits by CA led



**FIGURE 6** | Frequency of consumption (%) of meat sausage of CATA participants.

to a better understanding of the role of the characteristics of survey respondents on the perception of clean labels, food additives, and fresh sausage appearance attributes.

Figure 7 showed the CATA questions and scholarity. With 100% explanation, it was found that the statements related to the importance of using antioxidants and preservatives in meat sausage, as well as natural additives correspond better with participants with more education (post high school) ( $n = 134$ ; 67%). However, this same group revealed that they were not willing to pay more for products with natural additives, additionally stating that they have no knowledge about clean-label meat foods.

Participants with education up to secondary school ( $n = 52$ ; 26%) were the ones who indicated a willingness to pay more for meat sausage made with natural additives. Interestingly, this group also correlated with the belief that natural additives are not necessarily healthier than synthetic ones.

Figure 8 showed the correspondence between gender/age and CATA statements. With an explanation of 77.64%, the best correspondence revealed that men between 35 and 50 years old are those who value the color of meat sausage and who understand that the addition of preservatives and antioxidants to meat sausage is important. It was women aged between 31 and 50 who were willing to pay extra for meat sausage made with natural additives, and who stated that natural additives are healthier than synthetic ones, and who liked sausage with visible seasonings.

The statement related to the importance of the presence of visible fat in meat sausage corresponded to the groups of men and women aged between 18 and 30 years old and women between 31 and 50 years old.

The frequency of consumption of meat sausage and CATA statement (Figure 9) results revealed that participants who had a frequency of consumption of meat sausage from several times a week to several times a month corresponded better with the statements which highlighted the importance of using antioxidants

and preservatives in meat sausage and that natural additives are healthier than synthetic ones. Although a little more removed, the statement related to the knowledge about clean-label meat foods is also associated with these groups. Among these same consumers, color and the presence of visible fat and seasoning are important characteristics of the appearance of meat sausage.

#### 4 | Discussion

Globally, the natural food additives market is experiencing growth. Therefore, it is crucial to investigate consumption patterns, sensory perception, and comprehension of clean-label meats. For this research, fresh meat sausage, specifically, was chosen as the focal point of the study, as it is well-recognized for consumption in Brazil.

The frequency of consumption was researched both for meat sausage in general and specifically for fresh sausage. Meat sausage is known for being a very practical class of food for consumers. According to de Oliveira et al. (2020) the convenience of fresh sausage is one of the reasons for its high consumption by Brazilians. Price (Beck et al. 2021) and culture (Mürmann et al. 2009; Rossi et al. 2011) are other important reasons for consuming fresh sausages by Brazilians. The habit of consumption is mainly tied to the gaucho culture and their habit of eating barbecue (*churrasco*). Barbecue consumption by Brazilians is in fact a strong part of the food culture that plays a role in the population, not only a biological one but also a social role (Fernandes et al. 2022) and within this context, fresh sausage is almost always present.

The first results from UFP revealed the most important sensory attributes of fresh sausage to be considered in a sensory evaluation by consumers. Of the first five most cited attributes, two are related to appearance, highlighting the importance of this quality attribute for fresh sausage. The importance of the appearance of food was already described (Bordim et al. 2021, 2023; Cömert et al. 2020). In regard to meat quality, color is considered one of the most significant characteristics in food appearance

**TABLE 2** | Results of CATA questionnaire. Frequencies (%) for each sentence.

Code	Statement	%	Group
Q1	I would pay extra for meat sausage made with natural additives.	60.4	d
Q2	The addition of preservatives and antioxidants to meat sausage is important.	30.4	b
Q3	I do not like when sausage have visible seasonings.	14.2	a
Q4	I have knowledge about clean-label meat foods.	14.2	a
Q5	The addition of preservatives and antioxidants to meat sausage is not important.	4.06	a
Q6	Natural additives are healthier than synthetic ones.	62.9	d
Q7	I have no knowledge about clean-label meat foods.	51.2	cd
Q8	I would not pay extra for meat sausage made with natural additives.	11.1	a
Q9	Natural additives are not healthier than synthetic ones.	3.0	a
Q10	The presence of visible fat in meat sausage is not important to me.	10.6	a
Q11	I think the color of meat sausage is an important appearance attribute.	62.4	d
Q12	I like it when the sausage has visible seasonings.	37.5	bc
Q13	The presence of visible fat in meat sausage is important to me.	54.8	d
Q14	I do not think the color of meat sausage is an important appearance attribute.	6.0	a

Note: Different letters in the column indicate a significant difference between the number of checks in the check-all-that-apply questions by the Cochran's Q test ( $p \leq 0.05$ ).  $n = 200$ .

(de Oliveira et al. 2020). Red color was the most cited parameter to evaluate fresh sausage by consumers (Tapp III et al. 2011). This result is extremely important for the present study, since the ingredients studied have a direct effect on the color. (Santos et al. 2013) using the UFP technique and projective mapping generated attributes for describing prebiotic mortadellas. For both methodologies, red color was the most cited attribute.

Since red color was the focus in the generation of attributes to describe fresh sausage, this quality characteristic was explored in CATA together with the other well-mentioned appearance attributes. The sentence "I think the color of meat sausage is an important appearance attribute" was marked

by 62.4% of participants confirming the importance of this characteristic.

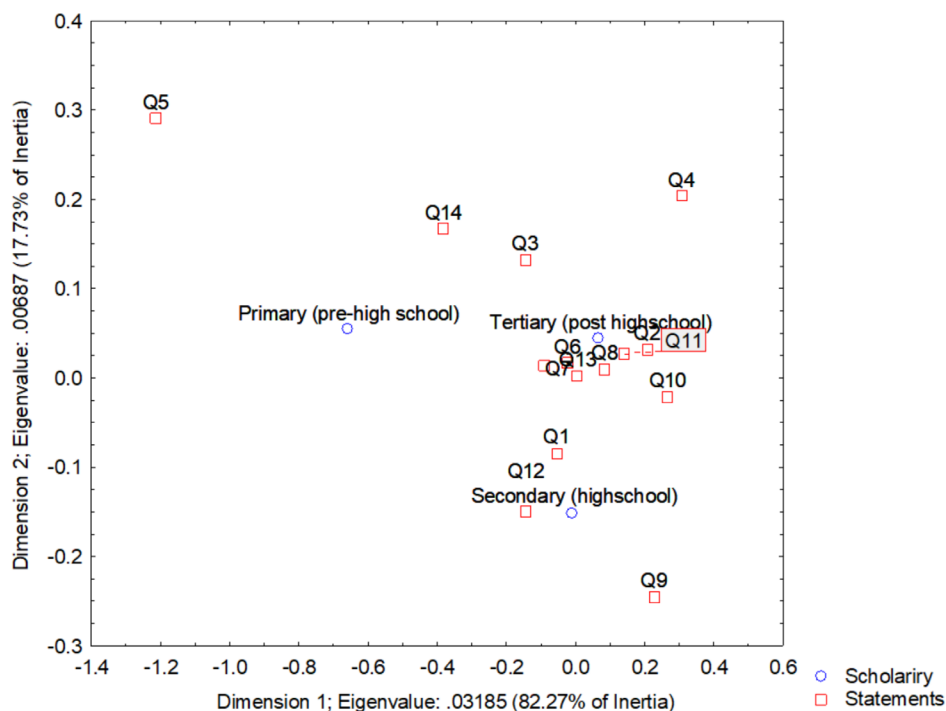
UFP allowed the survey of the sensory profile of the samples and to check the attributes that best discriminate them. In this study, the variables that played a significant role included red color, seasoning flavor, juiciness, and spiciness. If red color can be considered a prominent attribute in fresh sausage, it was the F1 and FC formulations that best correlated with this attribute. This result indicates that for the red color attribute, the concentration of 0.1% of celery extract was sufficient to promote the characteristic color of cured sausage. Nitrite, after its conversion into nitric oxide, combines with myoglobin, resulting in the formation of nitroso myoglobin, giving meat products a pinkish-red color (Tapp III et al. 2011). For other formulations, even those not corresponding to the red color attribute, the effect of the nitrite contained in the celery extract was effective, since the concentration was 0.1% or more. What may have happened was the masking of the red color, potentially due to the higher concentrations of celery and rosemary extracts combined with added curry. It is worth noting that all formulations received an equal concentration of beetroot coloring. Paradoxically, it was the formulations lacking or having lower concentrations of natural extracts that were associated with the seasoning flavor attribute.

The formulations with the highest concentrations of these extracts (F4 and F5) showed a prominent spiciness attribute, suggesting an enhanced perception of this attribute due to the increase in the concentration of extracts. Two extracts were used for preservative and antioxidant purposes, but realistically, the use of plant extracts as ingredients for the food industry often presents some limitations or difficulties in their use (Bordim et al. 2021, 2023; Carocho et al. 2018; Ohtaki et al. 2023). These limits are related to stability (Carocho et al. 2018) and the presence of unpleasant tastes and flavors, known as off-flavors (Bordim et al. 2021; Ohtaki et al. 2023), as well as the colors inherent in the ingredient (Bordim et al. 2021; Queiroz and Mitterer-Daltoé 2023). In the study by Bordim et al. (2021), the authors highlighted the potential for using natural extracts in various sectors of the food industry, but they also noted that not all natural extracts can serve as additives for all food sectors. In the specific case of using celery and rosemary extracts with curry in fresh sausage formulations, the perception of the spicy flavor can be seen as an advantage, since spicy flavorings are often used in this class of meat product.

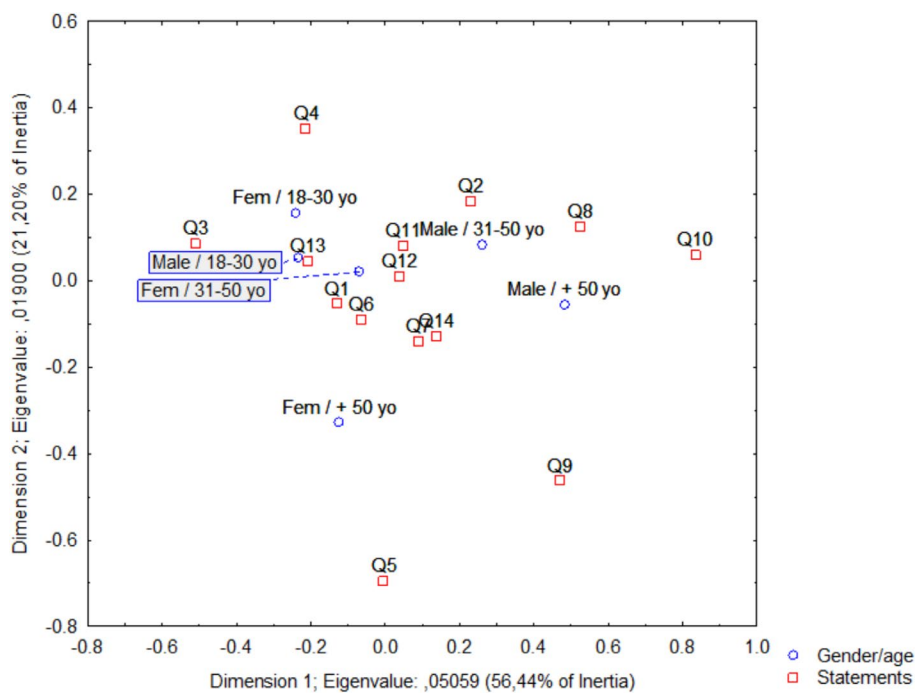
F2 and F3 formulations were characterized by the attribute of juiciness. According to the literature, natural additives from plant extracts can react with protein and improve water retention capacity (Zhou et al. 2020).

Results from CATA questions revealed that for the majority of participants, there was an understanding that natural additives are healthier than synthetic ones. However, at the same time, they were unfamiliar with the term clean-label, since only 14.2% of participants reported awareness of this term.

These results are in line with what the literature demonstrates about consumers and their perceptions and understanding of



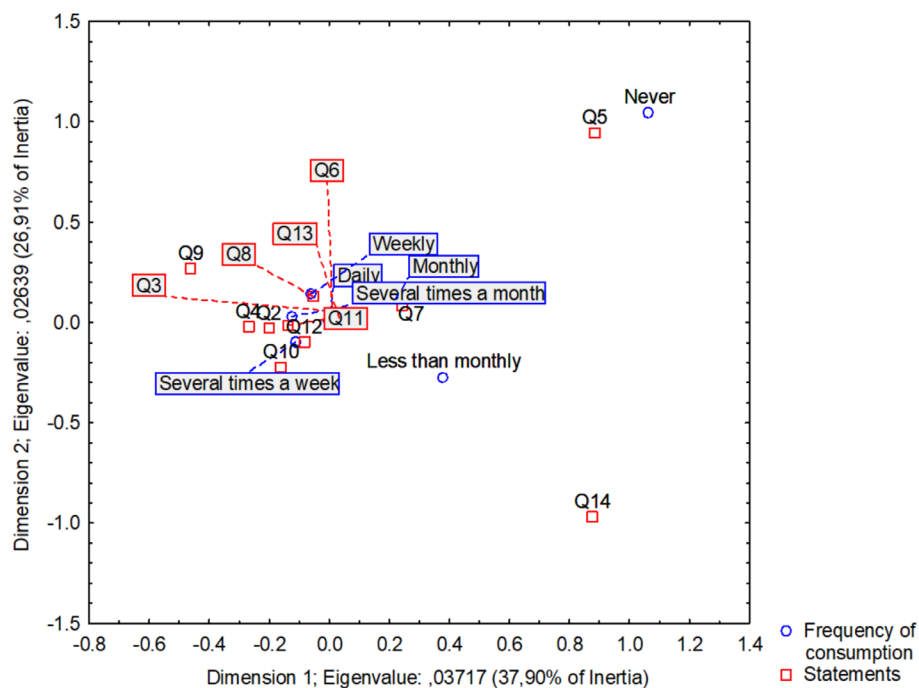
**FIGURE 7** | Correspondence analysis performed on data from CATA questions and scholary.



**FIGURE 8** | Correspondence analysis performed on data from CATA questions and gender/age.

chemicals in foods (de Araújo et al. 2022; Dickson-Spillmann et al. 2011), natural food antioxidants or colorants (Bordim et al. 2021; Mitterer-Daltoé et al. 2021) and food ingredients or additives (Aoki et al. 2010; Shim et al. 2011; Varela and Fiszman 2013). Specifically, with regard to meat products for consumers, the presence of chemical additives was a serious concern (de Araújo et al. 2022). For the present study, this became clear when only 30.4% of participants stated that

the addition of preservatives and antioxidants to meat sausage was important. Clearly, there is confusion and misunderstanding about the importance of the use of additives in meat derivatives, possibly because they are directly related to the terms preservatives and antioxidants of synthetic origin. It has been seen that consumers are unaware of the food safety importance of adding preservatives to meat derivatives, regardless of their origin (synthetic or natural). The studies



**FIGURE 9** | Correspondence analysis performed on data from CATA questions and frequency of consumption of meat sausage.

of (Dickson-Spillmann et al. 2011) found that consumers' concerns about chemicals in their diet and general attitudes toward chemicals influence perceptions in the food context. These authors also highlight the concern that some consumers present an excessively simple view of synthetic and natural ingredients: synthetic equals dangerous and natural and equal safety. For the authors, it is important to overcome this oversimplification so consumers will be able to judge food hazards more appropriately.

Common results were the positive perception of healthiness and food safety from consumers for natural additives (Shim et al. 2011; Varela and Fiszman 2013; Bordim et al. 2021). Another important finding from previous studies was that current consumers have little knowledge about food additives (Varela and Fiszman 2013); however, they are aware of this lack of knowledge (Aoki et al. 2010).

In the present study, the clean-label issue is no different. Participants stated that they did not know the meaning. However, this result should not be a surprise. In 2017, Asioli et al. (2017) highlighted "there is no common and objective definition of clean-label" and therefore the proposed objective of their study was to develop and suggest a definition of clean label. After extensive discussion, the researchers concluded that something like "free from" artificial additives would be a suitable definition. This definition was later investigated and reinforced in the study of Aschemann-Witzel et al. (2019). The authors found that consumers understand clean-label as containing natural, familiar, and simple ingredients. Although clean-label is a concept unknown to most participants, they are clear about the unhealthy aspects of synthetic additives, which makes them affirm their willingness to pay extra for foods containing natural additives. What is clear, therefore, is a need to publicize and clarify the term clean-label through advertising by the food industry.

The importance of the clean-label concept already exists. What does not exist is an awareness of the term. This statement is well demonstrated by the joint analyses between CATA and correspondent analyses, which allow for an exploration of the insights and consumers' personal characteristics.

It was found that participants with more education indicated that they were aware of the importance of using additives in food products, as well as that natural additives are healthier than synthetic ones. At the same time, this group of more educated people also had no knowledge about clean labels and no willingness to pay extra for them.

Women aged between 31 and 50 years old and with education up to secondary school stated that they paid more for meat sausage with natural additives. The importance given by women to issues of healthy food has been reported in the literature (da Veiga et al. 2021; Vila-López and Kuster-Boluda 2016). According to Vila-López and Kuster-Boluda (2016), women are significantly more involved in food than men, being also more worried about weight control and health. A significant finding is that the awareness of the importance of adding preservatives and antioxidants to meat sausage, along with concerns regarding synthetic additives, was more prevalent among consumers who frequently consume meat sausages. This evidence underscores the necessity for campaigns promoting a better knowledge of clean-label meat sausage.

## 5 | Conclusion

Meat sausage, and specifically fresh sausage, proved to be a class of food with great frequency of consumption by Brazilian participants. Red color, characteristic flavor, seasoning, visible fat, firmness, saltiness, tenderness, and greasiness were the most cited attributes to describe the fresh sausage, while red color,

seasoning, juiciness, and spiciness were the attributes that best discriminate among them. Different concentrations of celery and rosemary extracts with curry used in fresh sausage corresponded with different sensory profiles. Results from CATA questions revealed that a small number of participants thought that the addition of preservatives and antioxidants in meat sausage was important, while the majority of consumers understood that natural additives are healthier than synthetic ones. The term clean label was unknown to most participants. Results showed a misunderstanding about chemicals in food, additives, and a lack of knowledge about clean label. Clean label meat sausage should have good prospects since consumers value natural additives. What remains is to make consumers link natural additives to clean label products, and this is one of the challenges for the meat industry marketing sector.

### Author Contributions

**Paula Rabelo Sbardelotto:** writing – original draft, methodology, investigation, formal analysis, conceptualization. **Alexandre da Trindade Alfaro:** methodology, investigation, funding acquisition, writing – review and editing. **Alfredo Teixeira:** methodology, writing – review and editing. **Marina Leite Mitterer-Daltoé:** writing – review and editing, supervision, methodology, investigation, formal analysis.

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### Conflicts of Interest

The authors declare no conflicts of interest.

### Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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