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CONSUMER-BASED SENSORY CHARACTERIZATION AND PREFERENCE OF RAW AND PASTEURIZED MILK CHEESES

Preferência e caracterização sensorial baseada no consumidor de queijos de leite cru e de leite pasteurizado

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ABSTRACT

Unpasteurized cheese commercialization remains a big discussion nowadays due to safety concerns, although consumers prefer them over industrialized ones. Extrinsic attributes of raw milk cheeses such as proximity to producers, being artisanal and traditional are important for purchasing, but the taste remains the most important intrinsic parameter and is crucial for commercialization. The main objective of this scientific article is to evaluate consumers' preference for pasteurized milk cheeses (PMC) or raw milk cheeses (RMC) and to evaluate the differences between sensory attributes using the consumer-based methodology CATA (check-all-that-apply). One hundred individuals participated, and results showed that the cheesy and milk aromas, the taste of salty, the texture soft and the texture of smooth and moist did not differ whether the milk was heat treated or not. RMC presented higher intensity of acid odor and taste, higher bitter taste, visually with higher yellow intensity and a colonial appearance, and with a texture more crumbly and drier. PMC were sweeter, buttery, and with more whitish color than those made of unpasteurized milk. Brazilian consumers preferred the PMC, and aroma, moist, and sweet taste are critical attributes for cheese preference.

Keywords: unpasteurized; artisanal cheese; colonial cheese; sensory attributes; CATA methodology.

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RESUMO

A comercialização de queijos não pasteurizados continua sendo uma grande discussão atualmente devido a questões de segurança, embora os consumidores possam ter preferência por eles em detrimento dos industrializados. Atributos extrínsecos dos queijos de leite cru, como proximidade com os produtores, ser artesanal e tradicional, são importantes para a compra, mas o sabor permanece como o parâmetro intrínseco mais importante e é crucial para a comercialização. O principal objetivo do presente artigo científico é avaliar a preferência dos consumidores por queijos de leite pasteurizado (QLP) ou de queijos leite cru (QLC) e avaliar as diferenças entre os atributos sensoriais utilizando a metodologia baseada no consumidor CATA (check-all-that-apply). Cem indivíduos participaram, e os resultados mostraram que os aromas de queijo e leite, o sabor salgado, a textura macia e a textura lisa e úmida não diferiram se o leite foi tratado termicamente ou não. O QLC apresentou maior intensidade de odor e sabor ácido, maior sabor amargo, visualmente com maior intensidade de amarelo e aspecto colonial, e com textura mais friável e mais seca. Os QLP eram mais doces, amanteigados e com coloração mais esbranquiçada do que aqueles feitos com leite não pasteurizado. Os consumidores brasileiros preferiram o QLP, e aroma, sabor úmido e doce são atributos críticos para a preferência do queijo.

Palavras-Chave: não pasteurizado; queijo artesanal; queijo colonial; atributos sensoriais; metodologia CATA.

INTRODUCTION

Colonial cheeses are traditional dairy products in Southern Brazil and stand out as one of the most produced and consumed cheeses in the region. They are made from the basic cow's milk cheese process and are presented as a medium-fat, medium-moisture variety. Normative Instruction No. 30, of August 7, 2013, from the Ministry of Agriculture, Livestock and Supply, recommends a 60-day maturation period for cheeses made with raw milk. According to this legislation, for shorter development times, raw milk cheeses (RMC) can be marketed only if there is scientific proof of quality and safety (BRASIL, 2013).

The food safety of (RMC) has been widely discussed worldwide, especially the artisanal ones since they are more susceptible to contamination by foodborne pathogen microorganisms (PRETTO; SANT'ANNA, 2017). This feature (to be produced from raw milk) is an important criterion for willingness to buy cheeses (ALMLI *et al*., 2011), mainly because the traditional manufacturing process is valued by consumers (CRUZ; MENASCHE, 2014; ZIEMANN *et al*., 2022).

Colonial cheeses have been reported to be creamy, acid, bitter, salty, and present acid, milk, and butyric aroma, in addition to yellowish color and a bitter aftertaste (STEINBACH *et al*., 2021). Ambrosini *et al*. (2020) observed that consumers expect colonial cheese to present a gentile flavor, salty, and soft texture, which may be contradictory to ripped raw milk cheese.

Some recent articles evaluated consumers' perception of colonial and artisanal cheeses (AMBROSINI *et al*., 2020; STEINBACH *et al*., 2021; ZIEMANN *et al*., 2022), but few studied their sensory profile of them. Steinbach *et al*. (2021) characterized colonial cheeses by a trained panel and observed that, in general, products did not present complex sensory properties, mainly due to the short ripening period in their study, which was 10 days. Also, the authors reinforced the data that artisanal dairy products present a lack of standardization, showing samples with different sensory characteristics, although they were produced in the same region and during the same period of the year.

The presence of lactic acid bacteria (LAB) in RMC is essential for the development of a wide and unique variety of flavors and textures, which happens during dairy ripening (FERNANDES, 2009). During the ripening process, cheeses present strong reductions in moisture and pH, and an increase in the concentration of sodium chloride, leading to the control of undesirable bacteria and contributing to the development of beneficial microorganisms

responsible for the flavor and texture of cheeses (LECLERCQ-PERLAT *et al*., 2015; CALLON *et al.,* 2016). However, there is no information in the current dairy literature on about the pasteurization procedure impacts cheese characteristics and if consumers' sensory perceive the changes.

Check-all-that-apply (CATA) is a consumer-based descriptive and discriminative methodology that uses ordinary consumers to sensorily characterize foods. CATA uses a predefined list of attributes and consumers are asked to check all terms they considered appropriate for describing each sample. It is a very popular methodology due to the easiness of the task for non-expert panelists and the fact that consumers have been shown to be able to use this type of methodology to generate product spaces that are like those from trained assessors in the sense that they, by and large, identify the same relative similarities and differences between samples (VARELA; ARES, 2018). However, there are little data in the current literature that evaluate whether these features are felt by consumers and mainly if they lead to higher acceptance.

In these contexts, the hypothesis that no heat treatment of the milk really brings unique sensorial characteristics to cheese and if they impact positively on consumers' acceptance stands out for the food science field and industries. Thus, this study aims to evaluate the sensory characteristics of "colonial-type" cheeses, made with pasteurized and raw milk, using the check-all-that-apply (CATA) method, a consumer-based sensory characterization technique, and consumer preference among them.

MATERIALS AND METHODS

Cheese and ripening

The cheeses were produced following the traditional colonial-type cheese production procedure (AMBROSINI *et al*., 2020) in a supervised and legalized family agroindustry in Teutônia (RS, Brazil) in January 2021. The same type of milk was used as the base material for the cheeses, with part of the milk being pasteurized and the other part kept unpasteurized. So, two types of cheeses were made: pasteurized milk cheese and raw milk cheese. Milk pasteurization was performed in a plate pasteurizer at 72°C for 15 seconds. Pasteurized milk had 4.19% (±0.15) of fat and 87.005% (±0.005) of moisture, while raw milk had 3.85% (±0.15) of fat and 87.21% (0.005) of moisture. Both kinds of milk were kept at 32ºC for the addition of commercial calf rennet (1mL/10L of milk).

Commercial starter culture (BioTech, São Paulo, Brazil) of *Streptococcus salivaris subsp. termophilus, Lactobacillus casei, Lactococcus lactis subsp. lactis, Lactococcus lactis subsp. cremoris, Lactobacillus delbrueckii subsp. bulgaricus* and *Lactobacillus helveticus* were added to both samples (0.30g/10L). Pasteurized milk also was added to 3mL/10L of calcium chloride (BioTech Brazil). Coagulation, cutting, and salting of the curd followed traditional procedures (AMBROSINI *et al*., 2020), for both cheeses. Ripening of 500g samples of both types of cheeses happened in chambers with controlled humidity (75-80% relative humidity) for up to 60 days at a controlled temperature of 10ºC, following current Brazilian regulations (BRASIL, 2013).

Sensorial analysis

One hundred individuals (N=100), recruited by social media, were instructed about the sensorial tests, and signed informed consent before the experiment. The research was approved by the State University of Rio Grande do Sul's Research Ethics Committee (protocol 4.594.977) before the beginning of the study. Cheeses were analyzed for microbiological and physicochemical aspects before the sensorial trials.

Consumers initially were asked for their sociodemographic profile (gender, scholarly, monthly income, and the city they live in). Then, cheese samples with 60-day mature were offered and each taster carried out the analysis individually, in a bright environment free of sounds and odors that could influence the responses. Samples were presented in cubes and randomly coded in suitable containers. A list of 15 attributes (Aroma: cheesy, milk, acid, fruity, musty, odorless; taste: sweet, salty, buttery, bitter, acid; appearance: colonial, pleasant, yellow, whitish color, stained, holes; texture: fatty, soft, rubbery, crumbly, smooth, dry, moist) based on previous literature (STEINBACH *et al*., 2021) was presented and individuals were asked to analyze

each sample and check all attributes they felt. Then, consumers indicated their preference for one of the samples.

Microbiological and physicochemical analysis

Microbiological analyzes of *Listeria monocytogenes, Salmonella sp., Escherichia coli* and positive coagulase *Staphylococcus* were performed based on official Brazilian methodology (BRASIL, 2003). Moisture, fat, and pH were measured by classical methods described in AOAC, (HORWITZ, LATIMER, 2005).

Statistical analysis

Frequencies of mention for each word were determined by counting the number of consumers that used that word to describe each cheese, and the Q Cochran test was carried out for each of the terms, considering sample and consumer as sources of variation to evaluate if the CATA question was able to detect differences in consumers' perception of the evaluated samples. To get a bi-dimensional representation of the samples, correspondence analysis (CA) was used on the frequency table that contains the number of consumers who checked each term from the CATA question to describe each sample.

Microbiological and physicochemical analyzes were performed in three repetitions and means were compared by two-way analysis of variance (ANOVA) followed by Fischer's exact test, and statistical differences were considered when $p<0.05$.

All statistics followed the suggestion of Varela; Ares, (2018) and were performed at XLSAT (Addinsoft, Paris, France, version 2021.3.1).

RESULTS AND DISCUSSION

The profile of the consumers who participated in the work showed that they are between 18 and 60 years old, 45% were female and 39% finished high school (Table 1). Among the individuals, 85% self-reported consuming colonial cheese frequently.

Table 1. Consumers' sociodemographic characteristics. N=100

	%	N
Gender		
Male	55.0	55
Female	45.0	45
Scholarity		
Complete fundamental school	6.0	6
Complete high school	49.0	49
Complete graduation	45.0	45
Age		
18-25 years old	50.0	50
26-40 years old	27.0	27
41-60 years old	17.0	17
More than 60 years old	6.0	6
Frequency of consumption of colonial cheese		
Always	43.0%	43
Frequently	23.0%	23
Sometimes	19.0%	19
Never	2.0%	2
Did not answered	13.0%	13

Raw and pasteurized milk cheeses were within the legal standard parameters for microbiological and physicochemical analyzes (Table 2). *L. monocytogenes* and *Salmonella* sp. were absent in 25g of samples and *E. coli* and positive coagulase *Staphylococcus* were below the quantification limit. Moisture did not differ among RMC and pasteurized ones (p>0.05), and cheeses may be classified as low moisture (also known as hard mass cheese).

Both samples were classified as semi-fat cheeses since their concentration of fat was between 25.0 and 44.9% (BRASIL, 1996). The fat content was higher when the milk was pasteurized than in the traditional procedure (p<0.05), probably due to a methodological limitation of the fat analysis. In relation to pH values, they did not differ between samples (p>0.05). Steinbach *et al.* (2021) also observed little pH differences between samples made with unpasteurized milk and pasteurized ones. It is not uncommon that artisanal cheeses to be not able to human consumption due to foodborne pathogens. Carvalho *et al*. (2019) recently observed that just 33.3% of colonial cheeses presented a lower thermotolerant coliform population and 58.3% of positive coagulase *Staphylococcus* than Brazilian legislation established. Steinbach *et al.* (2021) were not able to perform sensory analysis of nine out of the fifteen colonial cheese samples due to microbiological aspects.

Table 2. Microbiological and physicochemical results of raw and pasteurized milk cheeses and Brazilian legal standards

Analyses	**Raw milk cheese (RMC)**	**Pasteurized milk cheese (PMC)**	**Brazilian standard**
Microbiological			
Listeria monocytogenes (CFU/25g)	Absent	Absent	Absent
Salmonella sp. (CFU/25g)	Absent	Absent	Absent
Escherichia coli (CFU/g)	$<10^1$	$<10^1$	10^2
Positive coagulase *Staphylococcus* (CFU/g)	$<10^1$	$<10^1$	10^3
Physicochemical			
Moisture (%)	23.96 ± 0.01^a	28.36 ± 1.36^a	< 36.
Fat	34.00 ± 0.00^b	36.00 ± 0.00^a	25-44.9
pH	4.56 ± 0.04^a	4.66 ± 0.05^a	none

Different superscript letters indicate statistical difference between raw and pasteurized milk at 5% of significance by Analysis of Variance (ANOVA) and Fischer's test.

After checking that samples were safe for consumption, sensory analyzes were performed. Results of the discriminative analysis of both samples by CATA are presented in Table 3. Fruity (n=4, 2%), musty (n=16, 8%), odorless (n=14, 7%), stained (n=1, 1%), holes (n=1, 1%), fatty (n=10, 5%) and rubbery (n=15, 8%) were attribute cited less than 10% of all possibilities, and thus they are not suitable for the description of the samples. Within this list, it is important to highlight the appearance attribute "holes": it was not cited by most of the consumers because cheeses did not present the typical holes in the center of the cheeses. Since all samples presented high microbiological quality, this feature was not presented. Brazilian cheeses' holes are mainly due to the presence of thermotolerant coliforms (SOUZA *et al*., 2003). However, the presence of holes in the center of cheeses is an important attribute of artisanal cheeses in Brazil from the consumers' point of view (AMBROSINI *et al*., 2020; ZIEMANN *et al*., 2022).

Thus, for further analysis, these attributes were removed. The aroma of cheesy and milk, the taste of salty, the texture soft, and the texture of smooth and moist did not differ (p>0.05) whether

the milk was heat treated or not. RMC presented higher (p<0.05) intensity of acid odor and taste, higher bitter taste, visually with higher yellow intensity and a colonial appearance, and with a texture more crumbly and drier. PMC was sweeter, more buttery (possibly due to PMC presenting a higher concentration of fat (p<0.05) (Table 2), and with more whitish color than RMC (p<0.05). Since RMCs keep their intrinsic microbiota, which mostly is composed of LAB, they may imply important changes in the sensory profile.

Table 3. Frequencies of mention for each attribute for raw milk and pasteurized milk cheeses by CATA method

	Attribute	Raw milk cheese (RMC)	Pasteurized milk cheese (PMC)
Aroma	Cheesy	76[a]	76[a]
	Milk	44[a]	49[a]
	Acid	22[a]	5[b]
	Fruity	2[a]	2[a]
	Musty	12[a]	4[b]
	Odorless	3[b]	11[a]
Taste	Sweet	2[b]	23[a]
	Salty	58[a]	50[a]
	Buttery	42[b]	58[a]
	Bitter	46[a]	18[b]
	Acid	22[a]	5[b]
Appearance	Colonial	62[a]	51[b]
	Pleasant	55[b]	65[a]
	Yellow	46[a]	31[b]
	Whitish color	11[b]	21[a]
	Stained	0[b]	1[a]
	Holes	1[a]	0[b]
Texture	Fatty	6[a]	4[a]
	Soft	60[a]	66[a]
	Rubbery	7[a]	8[a]
	Crumbly	28[a]	14[b]
	Smooth	40[a]	46[a]
	Dry	31[a]	16[b]
	Moist	11[a]	17[a]
	Preference	40[b]	60[a]

Different superscript letters indicate significant difference (p<0.05) between cheeses by Q Cochran test.

Steinbach *et al*. (2021) also observed using a trained panel that RMC was characterized by acid taste and aroma and bitter taste. The bitter taste related to these products is due to the hydrolysis of casein which initially results in large peptides, later in small peptides, and finally in free amino acids. The large peptides formed are usually tasteless or bitter and do not directly contribute to the typical flavor of the cheese (FARKYE, 2004). The higher acid odor and taste in RMC are related to organic acids, mainly lactic acid, produced by LAB and are felt by consumers, although they did not differ (p>0.05) on pH measurement (Table 2). Brazilian consumers characterized colonial cheese, one of the traditional raw milk cheeses in southern Brazil, as round and with a light yellowish color (AMBROSINI *et al*., 2020) and the main reasons for consumption would be characteristic flavor, aroma, and textures (STEINBACH *et al.,* 2021).

The results of the present work indicate that cheeses present a different appearance when milk is not pasteurized, which may be related to the higher yellow color in these samples (p<0.05).

Preference analysis showed that pasteurized milk cheese was preferred (p<0.05) over those raw milk cheese (Table 3) and Figure 1 shows the preference perception map based on the CATA, which statistical analysis shows that the main cheeses' feature related to consumers' preference were cheesy aroma, moist, and sweet taste.

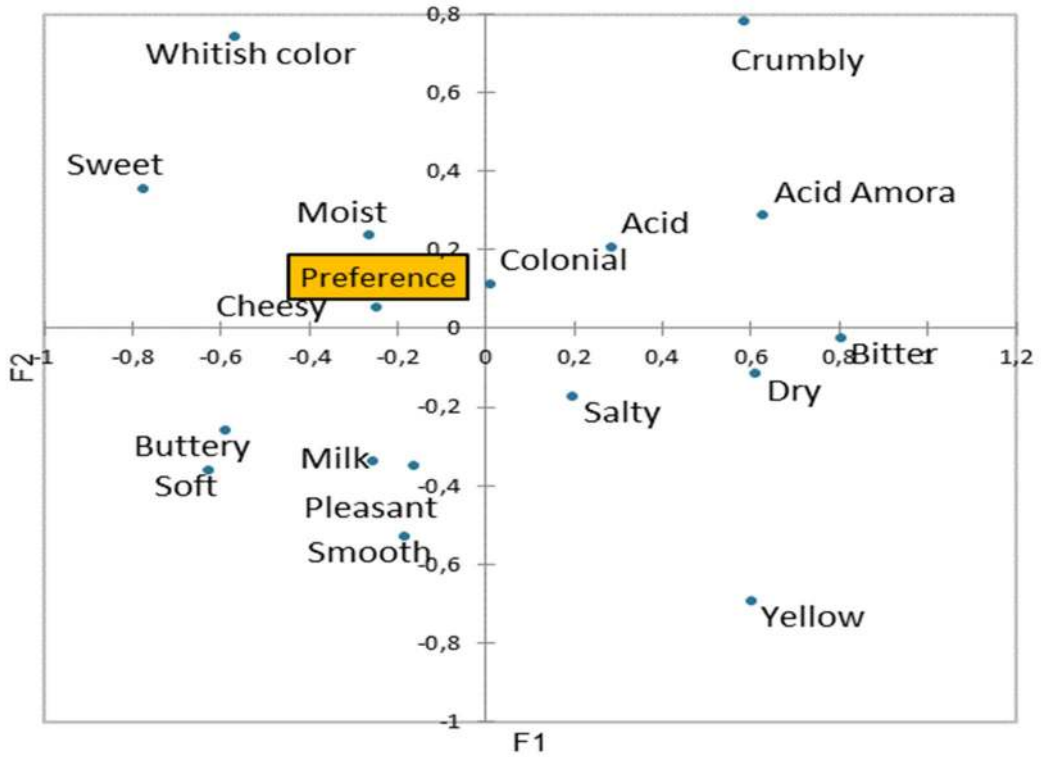

Figure 1. Preference perception map by correspondence analysis of CATA results and consumer preference.

For Steinbach *et al*. (2021), consumer perception was negatively affected by the acidity and springiness of colonial cheese samples, whose characteristics were found in the RMC sample. The preference for either PMC or RMC may be a cultural issue. Almli *et al*. (2011) observed that French consumers are more willing to buy raw milk cheese, while Norwegians prefer pasteurized. In Brazil, Steinbach *et al*. (2021) found that the number of consumers who consider it important for colonial cheese to be made with raw milk was not significantly greater than the number of consumers who consider production with pasteurized milk to be important. However, this study shows that consumers in southern Brazil prefer the taste of pasteurized milk cheeses.

CONCLUSION

In conclusion, the pasteurization of milk led to cheeses with different characteristics and PMC was preferred in the present study. The results show that the attributes of cheese aroma, moist and sweet taste are the most desired by consumers in southern Brazil when tasting colonial cheese. Consumers' purchasing and liking of food is complex and it is important to consider other non-sensorial attributes thus further studies are necessary to deeply explore these important food safety and security issues.

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.

REFERENCES

ALMLI, V. L. *et al.* Consumers' acceptance of innovations in traditional cheese. A comparative study in France and Norway. **Appetite**, v. 57, n. 1, p. 110-120, 2011. DOI: 10.1016/j.appet.2011.04.009

AMBROSINI, L. B. *et al.* Sabor, história e economia local: percepções dos consumidores gaúchos sobre o Queijo Colonial. **Pesquisa Agropecuária Gaúcha**, v. 26, p. 201-221, 2020. DOI: 10.36812/pag.2020261201-221

BRASIL, Ministério da Agricultura, Pecuária e Abastecimento. Portaria N° 146, de 07 de março de 1996. Aprova os Regulamentos Técnicos de Identidade e Qualidade dos Produtos Lácteos. 1996. **Diário Oficial da União:** seção 1, Brasília, DF, n. 48, p. 3977, 11 mar. 1996

BRASIL. Ministério da Agricultura, Pecuária e Abastecimento. Instrução Normativa nº 62, de 26 de agosto de 2003. Oficializa os Métodos Analíticos Oficiais para Análises Microbiológicas para Controle de Produtos de Origem Animal e Água. **Diário Oficial da União**: seção 1, Brasília, DF, n. 181, p. 14, 18 set. 2003.

BRASIL. Ministério da Agricultura, Pecuária e Abastecimento. Instrução Normativa nº 30, de 7 de agosto de 2013. Estabelece critérios adicionais para elaboração de Queijos Artesanais. **Diário Oficial da República Federativa do Brasil**: seção 1, Brasília, DF, n. 152, p. 19, 8 nov. 2013

CALLON, C.; ARLIGUIE, C.; MONTEL, M. C. Control of Shigatoxin-producing *Escherichia coli* in cheese by dairy bacterial strains. **Food Microbiology**. v. 53, p. 63-70, 2016. DOI: 10.1016/j.fm.2015.08.009

CARVALHO, M. M. *et al*. Traditional Colonial-type cheese from the south of Brazil: A case to support the new Brazilian laws for artisanal cheese production from raw milk. **Journal of Dairy Science**, v. 102, n. 11, p. 9711-9720, 2019. DOI: 10.3168/jds.2019-16373

CRUZ, F. T.; MENASCHE, R. Tradition and diversity jeopardised by food safety regulations? The Serrano Cheese case, Campos de Cima da Serra region, Brazil. **Food Policy**, v. 45, p. 116-124, 2014. DOI: 10.1016/j.foodpol.2013.04.014

FARKYE, N. Y. Cheese technology. **International Journal of Dairy Technology**, v. 57, n. 2-3, p. 91-98, 2004. DOI: 10.1111/j.1471-0307.2004.00146.x

FERNANDES, R. **Microbiology Handbook**: dairy products. Cambridge: RSC Publishing, 2009. 182p.

HORWITZ, W.; LATIMER Jr., G. W. (ed.). **Official methods of analysis of AOAC International**. 18th ed. Gaithersburg: AOAC International, 2005.

LECLERCQ-PERLAT, M. N. *et al*. Temperature and relative humidity influence the ripening descriptors of Camembert-type cheeses throughout ripening. **Journal of Dairy Science**, v. 98, n. 2, p. 1325-1335, 2015. DOI: 10.3168/jds.2014-8916

PRETTO, A. N.; SANT'ANNA, V. Queijo serrano: uma visão cultural, de qualidade e legal. **Vigilância Sanitária em Debate**, v. 5, n. 4, p. 81-87, 2017. DOI: 10.22239/2317-269X.00886

SOUZA, C. F. V.; ROSA, T. D.; AYUB, M. A. Z. Changes in the microbiological and physicochemical characteristics of serrano cheese during manufacture and ripening. **Brazilian Journal of Microbiology**, v. 34, p. 260-266, 2003. DOI: 10.1590/S1517-83822003000300016

STEINBACH, J. *et al*. Understanding consumer, consumption, and regional products: a case study on traditional colonial-type cheese from Brazil. **International Journal of Gastronomy and Food Science**, v. 26, e100418, 2021. DOI: 10.1016/j.ijgfs.2021.100418

VARELA, P.; ARES, G. Recent Advances in Consumer Science. *In*: ARES, G.; VARELA, P. **Methods in Consumer Research**. Cambridge: Woodhead Publishing, 2018. p. 3-21.

ZIEMANN, F. P. **Percepção dos consumidores de queijo sem inspeção sanitária oficial no Rio Grande do Sul.** 2022. Dissertação (Mestre em Ambiente e Sustentabilidade) – Universidade Estadual do Rio Grande do Sul. Francisco de Paula, 2018.