

## MONITORING THE TEMPERATURE OF REFRIGERATION COUNTERS AND BEEF SOLD IN BUTCHER SHOPS IN THE CITY OF CAMETÁ IN THE STATE OF PARÁ, BRAZIL.

### MONITORAMENTO DA TEMPERATURA DE BALCÕES DE REFRIGERAÇÃO E CARNES BOVINAS COMERCIALIZADAS EM AÇOUQUES NO MUNICÍPIO DE CAMETÁ NO ESTADO DO PARÁ, BRASIL

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#### SUMMARY

Meat is a very perishable product with a short shelf life, so the use of low temperatures is used to reduce the speed of chemical reactions, inhibit the growth of microorganisms, thus increasing the shelf life of this food. The objective of this work was to evaluate the temperature of fresh beef in refrigeration counters, and to monitor the temperature of this equipment in the butcher shop in the city of Cametá, Pará, Brazil, comparing it with the current legislation. In total, fifteen butcher shops were selected for this study, a skewer thermometer was used to measure the temperature of the meat, and a digital infrared thermometer was used for the counters. A statistical analysis was performed using Student's T test, using the average temperatures of the meats and the counters. It was found that among the temperatures, 23,33% of the meat samples (7/30) had their averages above the reference average (7°C), as well as the temperatures of the counters with 86,66% of the equipment (13/15), had an average temperature above the legal limit, which is 7°C. The study showed that the temperature of the counters and beef in the butchers were out of the quality standard, therefore a risk to consumer health, requiring stricter inspection and training of employees by public agencies.

**KEY-WORDS:** meat refrigeration, cold storage, legislation.

#### RESUMO

A carne é um produto muito perecível com vida útil curta, assim o emprego de baixas temperaturas é utilizado para diminuir a velocidade das reações químicas, inibir o crescimento dos microrganismos, aumentando assim a vida útil desse alimento. O objetivo deste trabalho, foi avaliar a temperatura de carnes bovinas *in natura* em balcões de refrigeração, e monitorar a temperatura destes equipamentos no comércio dos açougues no município de Cametá estado do Pará, Brasil, comparando com a legislação vigente. No total, quinze açougues foram selecionados para este estudo, na aferição da temperatura da carne foi utilizado um termômetro de espeto, e para os balcões, foi utilizado um termômetro digital infravermelho. Foi realizada uma análise estatística por meio do teste t de Student, utilizando as médias das temperaturas das carnes e dos balcões. Constatou-se que dentre as temperaturas, 23,33% das amostras de carne (7/30) estavam com suas médias acima da média referência (7°C), bem como as temperaturas dos balcões, com 86,66% dos equipamentos (13/15), estavam com a média da temperatura acima do permitido, pela legislação, que é de 7°C. O estudo demonstrou que a temperatura dos balcões e das carnes bovinas nos açougues, estavam fora do padrão de qualidade, portanto um risco a saúde do consumidor, sendo necessário uma fiscalização mais rigorosa e a capacitação de funcionários por parte dos órgãos públicos.

**PALAVRAS-CHAVE:** refrigeração da carne, conservação pelo frio, legislação

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## INTRODUCTION

Beef is considered a food of excellent nutritional quality due to the high biological value proteins present in its proximate composition (COSTA et al., 2017), and provides the main components necessary for the human diet (PAULA; LACERDA, 2016), being considered one of the most important foods for the Brazilian population and for the economic sector (HANGUI et al., 2015).

However, meat is a very perishable product with a short shelf life and therefore requires short sales times (NASTASIJEVIĆ; LAKIĆEVIĆ; PETROVIĆ, 2017). Its composition rich in nutrients, moisture and favorable pH, in addition to external factors such as temperature, hygienic conditions and gaseous atmosphere, provides microbial contamination from bleeding to commercialization and is generally involved in the spread of microorganisms that cause diseases (BORGES; SOUZA, 2019). Thus, even if the meat is obtained from healthy animals, it can be considered a potential contamination vehicle in several processing stages (FREITAS et al., 2018).

Thus, Brazilian legislation (BRASIL, 1996) recommends the immediate cooling or freezing of carcasses or beef cuts after slaughter. The maintenance of the cold chain is one of the main principles and basic requirements of food hygiene legislation (NASTASIJEVIĆ; LAKIĆEVIĆ; PETROVIĆ, 2017). For cattle, buffalo and swine slaughtering establishments, the recommended thing is that they can only sell meat with a temperature of up to 7°C, so that advances in hygienic, sanitary and technological terms are achieved in distribution and marketing, aiming at the health of the consumer (BRASIL, 1996).

The use of low temperatures has been widely used for food preservation, with the aim of slowing down chemical and enzymatic reactions, delaying or inhibiting the growth and activity of microorganisms (ROCHA et al., 2014). In this sense, the cold chain must not be interrupted at any time during the distribution of the meat (NASTASIJEVIĆ; LAKIĆEVIĆ; PETROVIĆ, 2017), as maintaining the temperature contributes to ensuring the microbiological and organoleptic quality of the products, however specific technical equipment and procedures are needed to maintain this chain, otherwise the safety and quality of the product changes when it is not kept in a suitable environment (DALLACORTE; DALANTON; COSTELLA, 2018).

From this perspective, when meat is stored in poor conditions, it develops unpleasant odors, which are generated due to microbial actions (BONACINA; BACCIN; ROSA, 2017). Temperature is one of the main factors to control microorganisms, so most meats must be kept under refrigeration or freezing (GAVIÃO et al., 2017). In refrigeration, the temperature is reduced to values between -1° and 8°C (BORGES; SOUZA, 2019).

However, even today meats are being marketed in different establishments, in inadequate conditions, exposed to various risks of contamination, affecting and compromising the final quality of the marketed product (SANTOS et al., 2016). Inappropriate storage, distribution and retail temperatures can lead to a significant reduction in shelf life and early deterioration of meat and meat products (NASTASIJEVIĆ; LAKIĆEVIĆ; PETROVIĆ,

2017). Damages are visible when there is no temperature control, which can cause batch loss due to the break in the cold chain, causing changes in the organoleptic characteristics of the meat, making its recovery impossible (BORGES; SOUZA, 2019).

It is necessary to have temperature control which must be strict in commercial establishments as well as checking the storage capacity of the counter or cold room, which is essential, since excesses of packaged products can also cause further deterioration of perishable products (OLIVEIRA et al., 2019).

For this, the temperature must be constantly monitored (CONZATTI; ADAMI; FASSINA., 2015) as well as the temperature of the equipment used for its storage (WIETHÖLTER; FASSINA, 2017). In commercial meat establishments, such as butchers, it is necessary to have this control, so that it reaches the consumer's table safely, requiring special care during all production and marketing, avoiding as much as possible conditions that put the consumer at risk (AVILA; KEHL, 2016).

Thus the aim of this study was to evaluate the temperature of beef and refrigeration equipment at the time of sale in butcher shops in the city of Cametá, in the state of Pará, Brazil, comparing the temperatures with Brazilian legislation.

## MATERIAL AND METHODS

For the study, 15 (Fifteen) butchers were selected, located in the city of Cametá, in the state of Pará, Brazil. The establishments were generically identified with the letters of the alphabet from A to O, (eg. Butcher A), in order to maintain confidentiality. The exploratory and descriptive research was carried out for three days consecutive, in the morning. The methodology followed that proposed by Borges & Souza (2019) and Oliveira et al. (2019).

In each butcher shop, two meat cuts of the *Paulista* type and the *Fraldinha* type were selected to measure the internal temperature. the temperature in the geometric center of the piece, thus totaling 30 (thirty) cuts. Simultaneously, the meat display equipment (refrigerator counter) was evaluated in terms of functioning, measuring their temperature at three different points (upper, central and lower). For this, a digital infrared thermometer, Incoterm® (-33°C ~ 199°C) was used. The thermometers purchased for measurements had calibration certificates, according to the manufacturer. Before and after the measurements, the thermometers were sanitized with non-recyclable paper towels and 70% alcohol.

To evaluate the collected data, the Student's T Test was applied (AYRES et al., 2007). Using the BioEstat program version 5.3, in order to identify the existence of significant differences between the temperatures measured on different measurement days, in order to evaluate the functioning of the equipment as well as the temperature of the meat sold. The significance level adopted for the application of Student's T tests was 5% (p-value < 0.05). The hypotheses constructed to evaluate the meat cuts were: H0: There is no difference between the average meat temperatures (three days) and the reference average. H1: There is a difference between the meat

temperature averages (three days) and the reference average. The hypotheses constructed for the evaluation of the equipment were: H0: There is no difference between the average temperatures of the equipment (three days) and the reference average. H1: There is a difference between the equipment temperature averages (three days) and the reference average.

The hypotheses raised aim to constantly evaluate the operation of the equipment as well as the influence on the temperature of the meat stored in them, for this purpose a reference value of 7°C was used, aiming at matching with the current legislation. The measurement method used by the legislation to evaluate the compliance with the meat refrigeration temperature, takes as reference

the individual measurement of both the meat and the equipment, in this way, an individual analysis of the measurements was carried out, on the different days of study, considering that the temperature average may not represent compliance from a legal point of view.

## RESULTS AND DISCUSSION

In this research, the results can be seen in Tables 1 and 2.

The results of the statistical analysis, through the Student T test, applied between the Average Meat Temperature (in the three days) x the Reference Average (7°C), are shown in Table 1.

**Table 1** - Average Temperature of Meat from Butchers in Cametá-PA, collected in 3 days, in 2019, and Student's T test result applied with the reference mean.

Butcher	Beef Cut	Temperature (°C)			Average	Standard deviation SD	t**	p-value*
		1 <sup>st</sup> Day	2 <sup>nd</sup> Day	3 <sup>rd</sup> Day				
A	P <sub>1</sub>	6,70	16,80	13,10	12,20	5,11	1,76	0,220
	F <sub>1</sub>	11,40	13,70	15,50	13,53	2,06	5,51	0,031*
B	P <sub>1</sub>	19,60	12,60	15,60	15,93	3,51	4,41	0,048*
	F <sub>1</sub>	17,10	7,90	8,50	11,17	5,15	1,40	0,296
C	P <sub>1</sub>	13,30	17,60	11,50	14,13	3,13	3,94	0,059
	F <sub>1</sub>	10,00	15,40	9,60	11,67	3,24	2,50	0,130
D	P <sub>1</sub>	1,70	1,10	1,70	1,50	0,35	-27,50	<0,0001*
	F <sub>1</sub>	21,00	2,10	1,50	8,20	11,09	0,19	0,869
E	P <sub>1</sub>	17,20	21,60	6,30	15,03	7,88	1,77	0,219
	F <sub>1</sub>	17,30	8,80	5,30	10,47	6,17	0,97	0,433
F	P <sub>1</sub>	2,20	8,20	16,50	8,97	7,18	0,47	0,682
	F <sub>1</sub>	14,20	3,10	23,10	13,47	10,02	1,12	0,380
G	P <sub>1</sub>	5,60	8,70	2,50	5,60	3,10	-0,78	0,516
	F <sub>1</sub>	4,60	12,50	13,30	10,13	4,81	-1,39	0,298
H	P <sub>1</sub>	3,80	4,00	6,00	4,60	1,22	-3,42	0,076
	F <sub>1</sub>	2,80	3,00	7,00	4,27	2,37	-2,00	0,184
I	P <sub>1</sub>	13,20	14,00	9,00	12,07	2,69	3,27	0,082
	F <sub>1</sub>	19,90	17,10	12,50	16,50	3,74	4,40	0,048*
J	P <sub>1</sub>	20,00	14,40	8,40	14,27	5,80	2,17	0,162
	F <sub>1</sub>	12,30	13,90	13,10	13,10	0,80	13,21	0,006*
K	P <sub>1</sub>	20,60	13,80	14,50	16,30	3,74	4,31	0,050
	F <sub>1</sub>	24,70	26,50	3,90	18,37	12,56	1,57	0,258
L	P <sub>1</sub>	14,60	16,80	10,90	14,10	2,98	4,12	0,054
	F <sub>1</sub>	14,80	14,50	15,00	14,77	0,25	53,45	<0,0001*
M	P <sub>1</sub>	19,70	12,00	10,10	13,93	5,08	2,36	0,142
	F <sub>1</sub>	16,80	16,10	9,70	14,20	3,91	3,19	0,086
N	P <sub>1</sub>	15,40	18,80	12,30	15,50	3,25	4,53	0,045*
	F <sub>1</sub>	3,10	17,90	15,10	12,03	7,86	1,11	0,383
O	P <sub>1</sub>	17,60	13,60	13,50	14,90	2,34	5,85	0,028*
	F <sub>1</sub>	14,30	21,10	11,70	15,70	4,85	3,10	0,090

Note: (\*) p-value with a significance level less than 5%;

(\*\*) Student's t test value.

P<sub>1</sub>= *Paulista* Cut

F<sub>1</sub>= *Fraldinha* Cut

According to the results of Table 1, it was found that 7/30 meat samples, that is 23,33%, have significant differences in their three day averages when compared to the reference temperature average. Where seven meat cuts had an average temperature above the reference average (p-value < 5%; t > 0). In the works by Oliveira et al. (2019), similar results were found with inadequacies

regarding meat temperatures, the temperatures of meat in pieces under refrigeration in supermarkets in Palmas, Tocantins were measured and it was found that all storage temperatures of Supermarket B were higher than the maximum recommended for this type of product (4°C), representing 100% inadequacy.

Through the evaluation carried out in the three days of measuring the temperatures of the cuts, Butchery A, Butchery B, Butchery I, Butchery J, Butchery L, Butchery N, and Butchery O do not present uniformity in the maintenance of the cold chain, to that the temperature of the cuts were kept within the recommended by the legislation, necessary for the conservation during the commercialization of the meat "in natura", being responsible for microbiological, sensorial and physicochemical alterations, and thus compromising the quality of the product and the health of the consumer. In similar studies, but using different methodologies, such as the studies by Borges & Souza (2019), who evaluated the conservation and packaging conditions of beef (*Patinho*, muscle and *Paleta*), in a commercial establishment located in Asa Norte, Brasília/ DF. In their results, they showed that the muscle cut, presented 60% of the samples outside the temperature standards (surface and center), since the surface temperature of *Patinho* all samples were altered, and the temperature of the meat center 40% were above the pattern. Likewise, in the researches of Bonacina; Baccin; Rosa (2017), revealed that all samples of ground beef sold in supermarkets in Erechim, Rio Grande do Sul, did not comply with the legislation regarding storage temperature.

The present study evaluated the average of temperature measurements in three days for meat cuts sold in butchers, to verify the operating conditions of the equipment and maintenance of the cold chain in the meat cuts sold, even though it is not the measurement parameter required by legislation, through individual measurements it was possible to assess whether the temperatures of the meat cuts were within the stipulated temperature of 7°C. Ninety measurements were performed on meat cuts in three days, and only 21,11%

(19/90) were at the ideal temperature recommended by law. In Souza's studies; Saints; Brito (2012), in five butcher shops in the city of Nossa Senhora da Glória, in Sergipe, observed temperatures between 4,7° and 18°C, that is, much higher than the safety limit for meat conservation.

In the present study, we considered possible causes of changes in the temperature of the meats in the equipment, they are: the door of the exhibitor counter is open for a long time, which allows high exchanges of heat between the internal and external environments; equipment with broken glass, with a defect in the sealing rubber, which allows it to malfunction, preventing it from reaching the proper cooling temperature; high external temperature, since no butcher shop was air-conditioned and the study city is hot, with collection being carried out in the morning; equipment exposed outside the establishment, being on the sidewalk on a public road, and not inside the protected place, as recommended by legislation; old equipment showing corrosion, rust and peeling; the lack of periodic maintenance of the same; the absence of temperature control records; as well as the possibility of turning off the device at night to save electricity. These factors can cause a wide variation in the temperatures of the meats sold, which make it difficult to maintain the cold chain, violate the legislation and put the health of the consumer at risk, who may be consuming meat outside the quality standard.

The results of the statistical analysis for the mean temperatures of refrigeration equipment, the Student T test was applied, in which the mean temperatures of the equipment (three days) were compared with the Reference Mean (7°C). Equipment temperature averages from a total of 15 butcher shops were used. And the values are shown in Table 2.

**Table 2** - Average Temperatures of the equipment at the Butchers of Cameté-PA, collected in 3 days, in 2019, and Student's T test result applied with the reference average.

Butcher	Temperature (°C)			Average	Standard deviation SD	t**	p-value*
	1 <sup>st</sup> Day	2 <sup>nd</sup> Day	3 <sup>rd</sup> Day				
A	20,00	15,00	15,50	16,83	2,75	6,18	0,025*
B	17,50	23,00	19,50	20,00	2,78	8,09	0,015*
C	15,50	13,00	15,00	14,50	1,32	9,82	0,010*
D	24,50	26,50	22,50	24,50	2,00	15,16	<0,0001*
E	23,00	31,00	26,00	26,67	4,04	8,43	0,014*
F	11,50	6,00	9,00	8,83	2,75	1,15	0,368
G	15,50	22,00	22,50	20,00	3,91	5,77	0,029*
H	24,00	23,00	22,00	23,00	1,00	27,71	<0,0001*
I	24,50	21,00	15,00	20,17	4,80	4,75	0,042*
J	12,50	13,50	15,00	13,67	1,26	9,18	0,012*
K	3,50	29,00	17,00	16,50	12,76	1,29	0,326
L	26,50	32,00	20,00	26,17	6,01	5,53	0,031*
M	23,00	16,50	24,50	21,33	4,25	5,84	0,028*
N	16,00	16,50	20,00	17,50	2,18	8,34	0,014*
O	23,50	24,50	15,50	21,17	4,93	4,97	0,038*

Note: (\*) p-value with a significance level less than 5%;  
(\*\*) Student's t test value.

According to the results of Table 2, it was found that among the temperatures of the 15 counters, 13/15 of them have significant differences in their three day

averages, when compared to the reference temperature average (7°C). Which represents 86,66% of the counters had their average temperature above the reference average

7°C (p-value < 5%; t > 0). Therefore, the equipment is in inadequate conditions to maintain the refrigeration temperature in the meat trade. In the studies by Oliveira et al. (2019), when they evaluated the refrigeration temperature of perishable products storage counters, in three supermarkets in the city of Palmas/To, and observed that only 33,33% (2/6) measured values were within the established temperature by the Legislation, while the other 66,7% were outside the standard, representing a risk to the consumer, it was observed that the refrigeration counters did not have a thermometer and temperature control spreadsheet.

Most of the failures in the maintenance of the cold chain are related to the conditions of the equipment where the meats are stored during the commercialization, in addition to the availability of its use and the owners' awareness of its use and maintenance. In the findings of Junior et al. (2020), found that there were failures regarding the storage conditions of raw meat sold in open markets, which were inadequate in the city of Santo Antônio de Jesus, in the interior of Bahia. In 94,10% (16) of the sales outlets surveyed, equipment for the preservation and/or storage of meat was available. Refrigerated counters 35,3% (6) and refrigerators 29,4% (5) were predominant. Freezers 17,6% (3) and cold rooms 11,8% (2) were also mentioned, but in many cases, failures were observed, such as temperature outside the proper range (> 5°C); meat storage was not in compliance with the maximum capacity of the equipment, making it difficult to effectively cool the pieces; in addition, frequent opening of the refrigerator doors puts the contents in contact with ambient air (+/- 30°C during the study period) resulted in high temperatures inside. Regarding temperature, very high temperatures were observed, which are far from those recommended for the preparation and preservation of fresh meat by refrigeration from 0° to 4°C, or freezing at -18°C. Although available in the vast majority of retail outlets, the coolers were overloaded, with insufficient cooling capacity, fluctuating and insufficient temperature control, all of which contribute to cold chain failures.

Similar results were found in the works by Santos et al. (2017), irregularities and inadequacies, the most serious are related to the lack of refrigeration of the meat sold in nine fairs in the city of Aracaju, in Sergipe. Baptista et al. (2013), when studying the qualitative aspects of meat sold in the metropolitan region of Recife/PE, observed that of the samples collected, only 2/20 were in agreement with the temperature values in the range of 0° to 4°C. These data indicate that the use of low temperature in establishments that sell meat occurs mostly improperly, as 14/20 samples were apparently refrigerated and, however only 2/14 were actually found.

Rocha et al. (2014), carried out a study on the conservation of refrigerated and frozen products exposed for sale in supermarkets in the city of Palmas/To, it was observed that the temperatures of the analyzed products diverged in their vast majority from the current legislation and the manufacturer's recommendation, in some cases presenting 100% unsatisfactory temperatures for storage.

Similar to this study, Achilles et al. (2017), carried out a study of Hygienic conditions in butcher shops in the city of Itaquí, Rio Grande do Sul, and in relation to meat

exposure equipment, the ideal temperature should be in the range of 4°C to 7°C, however, from 9 establishments studied, 2 of which were 4 and 6 the exposure equipment was at a temperature equal to -3°C and -4°C respectively. This temperature should be checked by employees at least on each shift, in order to guarantee a good sensory quality of the product and also to monitor the operation of the equipment, where the temperature was much lower than expected, therefore outside the recommended standard.

## CONCLUSIONS

The study showed that the temperature at which beef is sold in butchers in the city of Cametá is being performed inappropriately, as they did not meet the minimum temperature parameters for packaging, recommended by Brazilian legislation, therefore meat and equipment are at temperature outside the standard of quality. Thus, butchers must take security measures so that the meat is stored properly, monitoring and controlling the temperature. Municipal or state public agencies should offer training to employees / handlers on Good Manufacturing Practices, to be aware of the importance of maintaining the cold chain, and inspection agencies should intensify surveillance in these locations, in order to minimize risks to public health.

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