EVALUATION OF THE PARAMETERS OF CHARQUI MEAT AND JERKED BEEF MARKETED IN SOUTH OF BRAZIL

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ABSTRACT

Charqui and jerked beef, typical foods from certain regions of the Brazil. These products are interesting due to the added value to less noble meat, to meat from older animals and of doubtful sensory quality for fresh consumption. Physicochemical and microbiological analyses were performed on four different trademark of *charqui* and on three of jerked beef. The physicochemical tests were ascertained by moisture contents, ash, water activity (Aw) and pH. Regarding the microbiological testing, there was the estimated count of total coliforms and thermotolerants (MPN/g) and the enumeration of coagulase positive *Staphylococcus.* The objective of this study is to evaluate the quality of *Charqui* and jerked beef marked in the Southern Region of Brazil. The physical-chemical data for the samples analyzed were in accordance with the standards expected in current laws.

Key Words: intermediate water activity, moisture, total coliforms, thermos-tolerant coliforms, *Staphylococcus sp.*

1 - INTRODUCTION

It is known that the product known as *charqui* (sun-dried beef) appeared centuries ago among the Brazilians and data provided by Gouvêa and Gouvea (2007) say that this product was first produced over one hundred years ago in the state of Ceará (Northeastern Brazil) and then later in the state of Rio Grande do Sul (Southern Brazil), which consolidated the production of this product. According Pardi (1993) the *charqui* producing areas can be dated in the 1870s. According to research conducted by the Brazilian Institute of Geography and Statistics - the IBGE (INMETRO, 1998), meat products and derivatives showed increased consumption in Brazil. A characteristic example of this demand is the increase in consumption of the so-called *carne seca* (dried meat), a practice that until a few decades ago was restricted to North and Northeast of the country, but is now a commercial product and appreciated throughout the country.

In Brazil, there are commonly three products associated with the production of dried and salted meat. These products are *charqui*, jerked beef and *carne de sol* (sun-dried beef). *Carne de Sol* does not

have the technical regulation that would provide physicochemical and microbiological standards. There are also no regulations that provide a means of characterizing it legally in the RIISPOA (Inspection Regulations for Industrial and Animal Health Products Index) (Brazil, 1997).

More specifically, a study by Sousa et al. (2012), considered the profiles of consumers in Belém, Brazil, and observed an average consumption of 1.53 kg of charqui/month, with an average product price of R$ 27.16 Brazilian reals, or an equivalent of 4.88% of expenditures on food. The price was found to be responsible for the replacement of *charqui* by other protein sources in the region studied.

According Shimokomaki et al., (1998), Torres et al., (1994) and Chang et al., (1996), charqui is a product with intermediate water activity that does not required refrigerated storage. Another interesting point about this product is that it uses hurdle technology (Leistner, 1987), which ensures greater microbiological stability for the material.

According to the Ministry of Agriculture, jerked beef can be defined as follows: "It is understood by Jerked Beef or Beef Salt-Cured and dried; the industrialized meat product obtained from beef with added sodium chloride and curing salts, undergoes a process of maturation and desiccation "(Brazil, 2000). Thus, these salts are barriers that are used to inhibit the growth of microorganisms (Shimokomaki et al., 1998). The added salt, along with exposure to the sun, is a method of meat products preservation that is feasible with respect to microbiological stability (Youssef et al, 2011).

The prevailing laws in Brazil used currently, indicate that for jerked beef the maximum value of Aw is 0.78, 55% moisture, fixed mineral residue 18.3% and the addition of curing salts (Brazil, 2003). For *charqui*, there is 45% moisture, a fixed mineral residue (ashes) of 15% with a 5% variation allowedin in the intramuscular portion (Brazil, 1962). Values above 500 ppm of curing salts favor the formation of carcinogenic compounds because of the formation of nitrosamines (INMETRO, 1998). What also happens with most charqui producers is the addition of curing salts in charqui processing, in order to improve sensory and technological aspects, and therefore increase the stability of the product.

According to Lara et al. (2002), salty meat products may have pathogenic microorganisms, corroborated by Santana and Azeredo (2005), who detected the presence of *Staphylococcus aureus* in salted meats. Yet, under the subject of microbiological quality, other authors such as Pinto et al. (2002), indicate that the group of coliforms, such as *Escherichia coli* may be resistant to milder concentrations of salt. The same author indicates that with up to 5% salt, these microorganisms remain viable.

Studies by Costa and Silva (2001), reported that samples of *carne de sol*, a product similar to the products in this study, resulted in an average score for *Staphylococcus aureus* of more than 5.0 UFC; these values represent a considerable risk for thee presence of enterotoxins and may result in cases of food poisoning. The authors mentioned above also indicate that the microorganisms are halotolerant and can

withstand up to 15% salt, and are favored since there is a reduction of other competing microorganisms allowing their growth in a facilitated manner.

From this information one many elaborate, in a cohesive manner, the objectives of this study, which were to evaluate the quality of *charqui* and jerked beef marketed in Northern Paraná. The parameters analyzed were physicochemical and microbiological aspects that were directly related to the quality of these products.

2 - MATERIALS AND METHODS

2.1 - Samples

Samples were purchased in supermarkets of the Londrina region and neighboring towns in Brazil. *Charqui* samples were analyzed from four different *charqueadas* (place were charqui are produced) and three samples of jerked beef from different manufacturers. In the sampling design, three packs of the same batch were obtained randomly from each of the brands analyzed and each sample was analyzed in triplicate in the physical-chemical tests (AOAC, 1995). For the microbiological analysis, each sample was analyzed individually (Brazil, 2001). To perform the analysis the samples were ground in a domestic food processor and properly cleaned between sample preparations.

2.2 - Proximal composition, pH and Aw

Moisture and ash were determined according to the methodology proposed by the AOAC (1995). For moisture determination, the samples were properly weighed in a weighing filter and placed in an oven at 105° C. The material was cooled to room temperature in a desiccator, and weighing continued until a constant weight was obtained. To determine ash, the samples were weighed in porcelain crucibles. They were then calcinated at 600° C, and then cooled and the final weight obtained.

Water activity (Aw) was determined by a brand-name appliance, the Aqualab-Decagon Devices Inc., Model CX-2 at 25° C temperature (±1); for carrying out the measurements, the machine's protocols were followed. The hydrogenionical potential (pH) was performed according to the technique proposed by Terra and Brum (1988), with samples of 10g homogenized in 100ml of distilled water and the values were measured by digital potentiometer.

2.3 - Microbiological Analysis

For the enumeration of coagulase positive *Staphylococcus aureus* and the determination of the most probable number (MPN) of total coliforms and thermotolerant coliforms, we used the methodologies

recommended by the American Public Health Association - APHA (2001). For detection of *Salmonella* sp., we used ISO method 6579 (2007).

For confirmation of Staphylococcus coagulase positive samples in five typical colonies (spherical, with perfect and black edges, halo formation) were removed from the Baird-Parker supplemented agar (aqueous solution of 1% potassium tellurite, egg yolk emulsion and saline 1: 1) and subjected to the tests of coagulase, catalase, thermostable DNase and Gram stain.

In the analysis of total coliforms and coliforms termotolerantes, we used the technique of multiple tubes (3 sets of 3 tubes), using lauryl sulfate triptose broth for the presumptive test, and brilliant green broth and EC Broth for the confirmatory tests. The Most Probable Number count - MPN/g of the sample was performed using the Hoskings Table (APHA, 2001).

For the analysis of *Salmonella* sp., we used buffered peptone water (DIFCO) as a means of pre-enrichment followed by Kauffmann Tetrathionate Broth (DIFCO) and Rappaport-Vassiliadis (DIFCO). Confirmation of the presence of *Salmonella* sp., was carried out with suspect colonies growing in agar Xylose Lysine Deoxycholate - XLD (DIFCO) (red, with or without a black center), by means of the serum agglutination test, with use of antiserum for *Salmonella* "O" polyvalent (ISO, 2007).

2.4 - Statistical analysis

The results of the analysis of proximal composistion were analysed with the Statistica@ program by ANOVA and means test (Tukey) (Statsoft, 1995).

3 - RESULTS AND DISCUSSION

According to Article No. 431 of the Regulation of Industrial and Sanitary Inspection of Animal Products (RIISPOA), "beef that is cured and dried, is understood to be *charqui* without any specification." In addition, according to the RIISPOA, Article No. 432, "The charqui should not contain more than 45% (forty five percent) moisture in the muscular portion, or more than 15% (fifteen percent) of total fixed mineral residue, tolerating up to 5% (five percent) of variation." If the meat used is not beef, after the term "*charqui*" the species of origin should be clarified (Brazil, 1997).

Table 1 presents the results of the moisture and ash levels. As for moisture, all of the surveys of jerked beef were within the standards established by legislation (Brazil, 2003). Statistically, the samples of different manufacturers differed significantly among themselves within this 5%, suggesting the lack of standardization in the production of these meat products.

The values for ash were satisfactory in relation to those established by current legislation for all *charqui* samples analyzed; the same was result was obtained for the samples of jerked beef. The results obtained were satsifactory in relation to the quality of the products analyzed, indicating that, according to the levels of moisture and ashes (Table 1), both the *charqui* and jerked beef that were examined were in accord with the requirements under current Brazilian law, taking into consideration that there may be a variation of 5% in these levels.

Tables 1 - Mean value and standard deviation (triplicate) for the determination of moisture and ash obtained in samples of charqui and Jerked Beef marketed in northern Paraná.

Surveys	Moisture	Deviation*	Ashes	Deviation*
CHA	50.44 ± 1.55 [a]		18.26 ± 0.53 [a]	
CHB	47.91 ± 1.16 [b]	45.0%	17.01 ± 0.91 [b,c]	15.0%
CHC	43.91 ± 2.74 [c]	(BRASIL, 1962)	17.38 ± 0.37 [b,c]	(BRASIL, 1962)
CHD	44.58 ± 0.69 [d]		18.43 ± 1.12 [a]	
JBA	45.64 ± 1.91 [e]		19.08 ± 0.73 [d]	
JBB	47.53 ± 5.34 [a,b]	55.0% (BRASIL, 2003)	17.06 ± 1.23 [b,c]	18.3% (BRASIL, 2003)
JBC	45.58 ± 1.23[f]		16.93 ± 0.71 [b,c]	

* Standard deviation: maximum allowed value (± 5%). CHA - charqui, brand A; CHB - charqui, brand B; CHC - charqui, brand C; JBA - jerked beef, brand A; JBB - jerked beef, brand B; JBC - jerked beef, brand C. Means test: Different letters indicate differences between the samples and the same letters do not indicate a difference between the samples at a 5% significance.

Tables 2 - Mean values and standard deviation of Aw (water activity) and pH obtained for samples of charqui and jerked beef marketed in northern Paraná.

Surveys	Aw	pH
CHA	0.75 ± 0.0005 [a]	5.8 ± 0.03 [a]
CHB	0.77 ± 0.036 [b]	5.6 ± 0.14 [b,c]
CHC	0.75 ± 0.001[a,b,c]	5.8 ± 0.04 [a]
CHD	0.75 ± 0.001[a]	5.6 ± 0.13 [b,c]

JBA	$0.75 \pm 0.001^{a,d}$	5.7 ± 0.17^{d}
JBB	$0.75 \pm 0.004^{b,c}$	$5.6 \pm 0.14^{b,c}$
JBC	$0.80 \pm 0.004^{a,b,c,d}$	6.1 ± 0.16^{f}

CHA - charqui, brand A; CHB - charqui, brand B; CHC - charqui, brand C; JBA - jerked beef, brand A; JBB - jerked beef, brand B; JBC - jerked beef, brand C. Means test: Different letters indicate differences between the samples and the same letters do not indicate a difference between the samples at a 5% significance.

The samples that were analyzed showed pH values that are corroborated by those indicated by Shimokomaki et al. (1987). According to data provided by the National Reference Laboratory Animals (Lanara, 1981) pH values between 5.8 and 6.2 are considered raw meats fit for consumption, while values above 6.4 should be carefully analyzed and rejected by consumers due to the risk of microbial development.

The results of the microbiological analyzes (Table 3) showed that, although the samples CHC (07, 08, 09), JBB (16, 17, 18), JBC (19, 20, 21), CHD (10, 11, 12) having been performing confirmatory for total coliforms, all samples were negative on confirmatory testing for coliforms at 45° C. This indicates that the food was properly processed, without any contamination of fecal origin.

In the samples of charqui and jerked beef analyzed in this study, the count of *Staphylococcus* sp. ranged between < 10 and 1.1×10^7 CFU/g. However, *Staphylococcus* positive coagulase was not found. The thermonuclease tests (TNase) and coagulase conducted showed negative results for all suspected colonies previously isolated from Baird Parker supplemented agar. However, *Staphylococcus* sp. positive catalase was detected in nine (100.0%) charqui samples and seven (87.5%) of the jerked beef analyses; and the samples CHB (04) and JBC (19, 20, 21) with higher counts (range of 1.2×10^5 to 1.1×10^7 CFU/g), when compared to the other samples (Table 3). The water activity values and chloride concentration may have affected the viability of *Staphylococcus* sp., as the above-mentioned samples showed higher Aw values and lower concentrations of ashes than other samples.

The samples CHC (07, 08, 09) and CHD (10,11,12), presented simultaneously, had higher values of FMR (17.38% and 18.43%) combined with lower moisture content (43.91 and 44.58%) and lower counts of *Staphylococcus* sp., ranging from 1.8 to 6.3 10^3 CFU/g. Even though this microorganism tolerates high concentrations of NaCl (10-20%), possibly lower humidity values did not allow their multiplication in these samples. Only three samples of charqui (CHA 3, CHB 05 and CHB 06) and two of jerked beef (JBB 14 and JBB 16) had a *Staphylococcus* sp. count <10, indicating an absence of the initial contamination of the product.

Although several fixed mineral residue concentrations (chlorides) can influence the survival of different species of the Staphylococcus genus, this microorganism can resist all chloride concentrations found in the samples. Although the minimum value of AW is 0.86 for the growth of Staphylococcus sp. under ideal conditions where other intrinsic and extrinsic factors may allow its development in A_W 0.83 (Jay, 1992).

Thus, if we consider this parameter, none of the samples offered conditions for the development of these bacteria. However, the results for samples CHB (04) and JBC (19, 20, 21) show that the number of *Staphylococcus* sp. in these samples was higher than in the others. Given that these foods are manufactured by hand, this may introduce initial microbial loads that are highly viable in this microorganism.

Moreover, considering the fact that this bacterium does not compete well with other microorganisms, and that both in the charqui and in the jerked beef there are high chloride concentrations, *Staphylococcus* spp. has no other competitors making their viability possible in these products. Pinto et al. (1998) used two innocuous strains of staphylococci in the manufacture of jerked beef that were obtained because of the inhibition of *Staphylococcus aureus* by competition. These researchers have suggested that to increase the safety and standardization of jerked beef that selected bacterial cultures would be a solution.

In other microbiological analyses, all samples analyzed showed low levels of total coliforms (variation between <3 and 460 MPN/g), <3 MPN/g of coliforms at 45° C and the absence of *Salmonella* sp./25 g, indicating a good microbiological quality of the products and, therefore, suitability for human consumption. These results are justified because these microorganisms need Aw values greater than 0.95, in addition to being intolerant to high concentrations of salt.

Table 3 - Mean Staphylococcus spp count and Most Probable Number (MPN) of total coliforms and thermotolerant coliforms in charqui samples and jerked beef marketed in northern Paraná.

Surveys	*Staphylococcus* sp. (CFU/g)	Coliforms totals (MPN/g)	Coliforms to 45ºC (MPN/g)
CHA (01)	3.0×10^4	< 3	< 3
CHA (02)	5.2×10^3	< 3	< 3
CHA (03)	< 10	< 3	< 3
CHB (04)	2.8×10^5	< 3	<3
CHB (05)	< 10	< 3	< 3
CHB (06)	< 10	< 3	< 3
CHC (07)	3.9×10^3	460	<3
CHC (08)	3.1×10^3	150	<3

CHC (09)	1.8×10^3	75	< 3
CHD (10)	5.6×10^3	150	< 3
CHD (11)	6.3×10^3	93	< 3
CHD (12)	4.4×10^3	43	< 3
JBA (13)	1.1×10^4	< 3	< 3
JBA (14)	< 10	< 3	< 3
JBA (15)	3.4×10^4	< 3	< 3
JBB (16)	< 10	< 3	< 3
JBB (17)	1.8×10^4	75	< 3
JBB (18)	2.2×10^4	210	< 3
JBC (19)	1.2×10^5	43	< 3
JBC (20)	1.1×10^7	460	< 3
JBC (21)	8.6×10^5	7	< 3

CHA - charqui, brand A; CHB - charqui, brand B; CHC - charqui, brand C; JBA - jerked beef, brand A; JBB - jerked beef, brand B; JBC - jerked beef, brand C.

4 - CONCLUSION

In general, the samples of charqui and jerked beef that are marketed in northern Paraná are marketed under conditions that comply with current legislation in Brazil. This is a plus point for these animal products that tend to be held in suspicion by consumers because they are usually held to be food of dubious sanitary hygeine, although being widely accepted by many consumers, a portion of the population believes in the absence of sanitary hygienic control of these products. Regarding microbiological tests, both in beef jerky and in jerky pathogenic microorganisms were not found. This is a factor of great importance for the consumer, who will be able to consume the products without causing damage his/her health and, at the same time to avoid establishing a negative relationship between charqui, jerked beef and bad microbiological quality. Thus, with the drafting of this study it can be concluded that in relation to microbiological aspects and constitution, products marketed in Paraná State exhibit good quality when they arrive at the consumer's table; however, there exists a great difference among products from different charqui producers. When processing is the same for the different producers, the products should at least be similar in many ways, but this was not observed. Soon it will be concluded that there is need for standardization in the development of these products in order to improve the quality of cured and salted meats produced in the country.

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