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Research Article

Contamination by aerobic mesophilal and enterobacteriaceae bacteria in a pig refrigerator

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Abstract

The study aimed to evaluate the knives, contact surfaces and carcasses for contamination by mesophilic aerobic bacteria and Enterobacteriaceae, in a pig slaughterhouse in the state of Rio Grande do Sul. The present study took place in a pig slaughterhouse, located in the Northwest Region of the State of Rio Grande do Sul, under the Federal Inspection Service (SIF). The experimental design used was randomized blocks organized in a bifactorial scheme, being for the knives: 3 (days of collection) x 3 x 15 (time of collection and knives from the slaughter and deboning process), totaling 135 experimental units for the knives. For water, main contact surfaces and pig carcasses, a unifactorial scheme was used: 3 (days of collection) x 12 surfaces (5 contact surfaces and 7 carcasses), totaling 36 experimental units. Knives used during slaughter operations are a form of contamination. There is deficiency in the pre-operational hygiene procedure of the utensils.

Keywords: Sanitation, quality control, food safety, microbial count, correlation, regression.

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Introduction

Pork is the second most consumed meat in the world, according to OECD/FAO data from 2022. According to the latest projections from these organizations for the year 2031, global demand for pork is expected to reach 128.9 million tons. According to the 2022 annual report released by the Brazilian Association of Animal Protein (ABPA), in Brazil, pork production in 2022 was 4.35 million tons of meat, 70% destined for internal market and 30% for external market (Associação Brasileira de Proteína Animal [ABPA], 2022).

National legislation and international standards, regarding to the hygiene of products of animal origin, indicate the need to direct actions to all stages of the pork production chain, in order to protect the consumers' health (Martins et al., 2014). In the production process, the effectiveness of cleaning and disinfection must be monitored by regular controls, based on microbiological tests on surfaces, equipment and instruments, essential for the manufacture of safe foods (Bari & Kawasaki, 2014).

Hygiene procedures failures may lead to cross-contamination, which occurs by transferring microorganisms from one person, object or place to another, directly or indirectly, from a contaminated item to an uncontaminated item. An example is the insufficient disinfection of knives at slaughter and following stages, which may lead to cross contamination from one cut to another (Rocha, Vilela, & Pinto, 1999; Franco & Landgraf, 2008; Swart et al., 2016).

Tools used in the evisceration of pigs present a high risk of microbial contamination, due to injuries caused by knives, resulting in extravasation of intestinal contents, making it a vehicle for contamination by pathogens (Rossvoll, Rotterud, Hauge, & Alvseike, 2018). As may also occur in deboning, in which microorganisms may be transferred during the use of knives, when cutting carcasses (Barbosa et al., 2016).

In order to collaborate with the identification of points of contamination in the process, studies evaluate the hygienic-sanitary conditions, through the evaluation of mesophilic aerobic bacteria and of the Enterobacteriaceae family, and microorganisms considered indicators of quality and hygiene, which makes it possible to identify and indicate potential points for improvement along the production line, as well as monitoring conditions for surface hygiene (Biasino et al., 2018). From this point of view, the microbiological validation of the time interval in the use of tools on the production line is an important risk analysis approach. In view of the above, the study aimed to evaluate the knives, contact surfaces and carcasses for contamination by mesophilic aerobic bacteria and Enterobacteriaceae, in a pig slaughterhouse in the state of Rio Grande do Sul.

Material and Methods

The present study took place in a pig slaughterhouse, located in the Northwest Region of the State of Rio Grande do Sul, under the Federal Inspection Service (SIF). Slaughter plan operations involve reception, pre-slaughter rest, slaughter, deboning and production of industrialized products, finally delivering.

The experimental design used was randomized blocks organized in a bifactorial scheme, being for the knives: 3 (days of collection) x 3 (time of collection, in minutes) x 15 (knives from the slaughter and deboning process), totaling 135 experimental units formed by 15 knives for each collection time (Table 1). For water, main contact surfaces and pig carcasses, a unifactorial scheme was used: 3 (days of collection) x 12 surfaces (5 contact surfaces and 7 carcasses), totaling 36 experimental units (Table 2). Sampling knives, water from the scalding tank, equipment and pig carcasses with collections through sterilized swabs and coded according to collection points and times.

Each operator in the slaughter room has a set of knives with handles of different colors to change every three minutes during the process. Thus, the collection stages were in accordance with the SOPs for the knives, followed by the slaughterhouse. In the first slaughter stage, samples were collected through swabs, (1) from the knife surface after sterilization (time 0), (2) in the middle of the knife change period, that is, after 1.5 minutes of use (time 1) of the same and, finally, (3) after three minutes of use (time 2).

Table 1. Number of knives sampled, for the evaluation of mesophilic aerobic bacteria and Enterobacteriaceae, used in a pig slaughterhouse.

Treatments	Samples	Slaughter stage
1	Scraping knife	Manual scraping
2	Jowl opening knife	Evisceration
3	Belly opening knife	Evisceration
4	Tail cut knife	Evisceration
5	White viscera knife	Evisceration
6	Red viscera knife	Evisceration
7	Knife 1 Leg	Carcass division
8	Knife 2 Leg	Pork cuts trimming
9	Knife 3 Leg	Pork cuts trimming
10	Knife 1 Shoulder	Carcass division
11	Knife 2 Shoulder	Pork cuts trimming
12	Knife 3 Shoulder	Pork cuts trimming
13	Knife 1 Belly	Carcass division
14	Knife 2 Belly	Pork cuts trimming
15	Knife 3 Belly	Pork cuts trimming
	Days: 3 collection days	

*(15 treatments x 3 stages x 3 collection days = 135 samples x 2 microorganisms/analyses = 270 determinations).

In the deboning room, each operator receives a knife that changes after 3 hours and 10 minutes. The boning knives were collected through swabs (1) of the surface of the sanitized knife (time 0), (2) after 1 hour and 35 minutes of use and (time 1), (3) before the knife was collected for the cleaning process again, after 3 hours and 10 minutes (time 2).

The boning knives are sanitized over the entire surface, by means of a pre-rinse with water under pressure of 5-10 Kgf/cm² at a temperature between 45 - 55 ºC, then detergent is applied and left to act for 10 minutes, after rinsing is carried out with water under pressure of 5-10 Kgf/cm² at a temperature between 45 – 55 ºC and the cleaning process is completed by immersing the knives in a sanitizing solution. As in the tables above, obtaining one hundred seventy-one (171) samples, to this total, applying analyzes for two groups of microorganisms and carrying out the collections in two environments: slaughter and deboning.

Table 2. Main contact surfaces and pig carcasses sampled for the evaluation of mesophilic aerobic bacteria and Enterobacteriaceae in a pig slaughterhouse.

Treatments	Samples	Slaughter Stage
1	Scalding tank water	Scalding
2	Rehang table	Rehang
3	Polisher 01	Dry Polishing
4	Polisher 02	Wet Polishing
5	Polisher 03	Polish /Wash pre-eviscer.
6	Carcass-Rehanging Table	Rehang
7	Carcass-After wet polishing	Wet Polishing
8	Carcass-Entrance in the clean zone	Evisceration
9	Carcass-Before white visc.	Evisceration
10	Carcass-After red visc.	Evisceration
11	Carcass-Official Inspection	Inspection
12	Carcass-After final wash	Final wash

*(12 treatments x 3 collection days = 36 samples x 2 microorganisms/analyses = 72 determinations).

Selecting the evaluated surfaces based on the microbiological results obtained by the industry according to the levels of microbial contamination previously found, as well as the incidence of non-compliance with the exchange of knives, in the slaughter in the Safe Operational Procedure. For sample collection, previously identified sterile swabs were used at each point, with the sampling points and after the smear, the swab was deposited inside the test tube containing 1% peptone water and closed immediately. It was not possible to apply the area delimiter template, as it is a small tool. Thus, an area of 50 cm^2 was visually defined and the sample was collected, applying pressure to swabs and an inclination of approximately 45º (forty-five degrees), at least 10 times, and rotating so that the entire surface of the swab was in contact with the knife surface (European Commission [EC], 2001).

Carrying out water collections from the scalding tank at the time of collection from the surface of the slaughter knives. Collecting the volume of 15 mL of water from the tank in a sterile collection tube. Carrying out the collection of equipment at time 02 of the collection of knives. Rehanging table, polishing machine 01 (dry), polishing machine two (wet) and polishing machine 03 (final wash/ scraping) were rubbed using sterile swabs on a total surface of 50 cm^2, using molds with an area of 10 cm^2 that allowed the surface to be sampled at 5 (five) different points, increasing the representativeness of the sample (EC, 2001).

Collecting carcass samples at time 02 of knife collection. In order to collect samples from the surface of the carcasses, sterile swabs were rubbed on the carcasses, located in four anatomical regions (leg, loin, belly and jowls), totaling a sampling area of 400 cm^2, method recommended in Circular 130/2007/CGPE /DIPOA (Ministério da Agricultura, do Abastecimento e Reforma Agrária [MAPA], 2007). Transporting the collected samples in a thermal box to the company's accredited laboratory located in Itapiranga-SC, and submitted to analyze for counts of mesophilic and Enterobacteriaceae aerobes.

For the counting of mesophilic aerobic microorganisms, Petrifilm plates (3M, Saint Paul, MN, USA) used according to the methodological guidelines of the

Association of Official Analytical Chemists (AOAC) (2012). Inoculation of 1mL of the sample was carried out in decimal dilutions from 10^{-1} to 10^{-4}, in plates with Aerobic Count Plate (AC) medium, which contains, in addition to nutrients, 2,3,5-triphenyltetrazoic chloride. Distributing the sample in an area of 20 cm^2, with incubation at 35 °C ± 1 °C for 48 hours ± 3 hours; after the incubation period, all colonies with growth characteristics in red were counted (AOAC, 2016a,b).

While, for the Enterobacteriaceae count, using Petrifilm plates (3M, Saint Paul, MN, USA) according to the methodological guidelines of the AOAC (2012). Inoculation of 1mL of the sample performed in decimal dilutions from 10^{-1} to 10^{-4}, in plates with Enterobacteriaceae Count Plate medium, which has red violet bile agar (VRBA). 1 mL of sample added on the plate, in an area of 20 cm^2, and submitted to incubation at 37 °C ± 1 °C for 24 hours ± 2 hours. After the incubation period, all colonies with growth characteristics in red with yellow zones and/or red with air bubbles with or without yellow zones were counted (AOAC, 2016a,b). After the incubation period, the colonies present in the agar of the plates were counted and expressed in log CFU/cm^2.

Submitting the data to the assumptions of the statistical model, normality, homogeneity and additivity, later the analysis of variance at 5% probability applied in order to identify the interaction between collection points x exposure times. Considering the sampling point variation factor qualitative and its dismemberment occurred through the comparison of averages by Duncan. Considering the time variation factor quantitative and its breakdown was expressed by linear regression with polynomial adjustment through the t test at 5% probability. In order to identify associations within the study, stratified linear correlations were performed, by carcass effects, effects of knives at slaughter, effects of knives at deboning and effects for equipment. Its significance supported by the t-test at 5% probability.

Results and Discussion

The two-factor scheme did not show interaction for the dependent variables (mesophilic aerobes and Enterobacteriaceae) therefore, it was based on the main effects. Table 03 shows the counts of hygiene indicator microorganisms on six knives used in the pig slaughter process.

Table 3. Counts of mesophilic aerobic bacteria and Enterobacteriaceae (mean ± standard deviation), at different times of use of knives, during slaughter.

Knives Slaughter	Aerobic Mesophiles log UFC/cm²			Enterobacteriaceae log UFC/cm²		
	Time 0	Time 1	Time 2	Time 0	Time 1	Time 2
Scraping	0.20±0.28	1.72±0.15	1.67±0.51	0.00±0.00	0.00±0.00	0.00±0.00
Double sword	0.10±0.14	0.87±0.62	1.29±0.44	0.00±0.00	0.00±0.00	0.00±0.00
Belly	0.00±0.67	0.81±0.43	0.55±0.40	0.00±0.00	0.20±0.28	0.00±0.00
Tail	0.16±0.22	1.29±0.36	1.25±0.43	0.00±0.00	0.00±0.00	0.00±0.00
White viscera	0.00±0.00	0.23±0.33	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
Red viscera	0.10±0.14	0.76±0.54	1.09±0.47	0.00±0.00	0.20±0.28	0.36±0.51

* For knives, considering each sample collection date a repetition. Time 0: 0 min. Time 1: 1.5 min. Time 2: 3 min.

In the analyzes of mesophilic aerobes, the mean variation was between 0.00 and 0.20 log CFU/cm^2 at time 0, between 0.23 and 1.72 log CFU/cm^2 at time 1, and between 0.00 and 1 .67 log CFU/cm^2 at time 2. While the Enterobacteriaceae counts were absent at time 0, but at time 1 it varied between 0.00 and 0.20 log CFU/cm^2 and at time 2 between 0.00 and 0 .36 log CFU/cm^2.

Brazilian legislation does not define microbiological parameters for surfaces of equipment and utensils used in food processing. However, for slaughterhouses exporting to the Asian market and the European Union, the microbiological parameters for acceptable mesophilic aerobics is up to 1 log CFU/cm² and absence for Enterobacteriaceae (EC, 2005).

Of the results obtained in the analyzes of mesophilic aerobes carried out on the slaughtering knives, 33% presented counts above the standard compared to the permitted levels of Decision 471 of the European Community. For Enterobacteriaceae, 17% of the results showed levels above what is allowed, according to this same legislation. Slaughter knives are sanitized every 3 minutes, through rinsing and subsequently sterilized in circulating water sterilizers, at a temperature of 82.2 ºC, throughout the slaughter process, as determined by Ordinance No. 711, of 01 of November 1995 (MAPA, 1995).

According to these results, it is observed that the process of sterilizing the knives for 3 min, at a minimum temperature of 82.2 ºC at time 0 (zero), during the different slaughter operations, was efficient. Thus, the counts of mesophilic aerobic bacteria and Enterobacteriaceae are considered acceptable, according to Decision 471 of the European Community (EC, 2001), demonstrating the efficiency of the sterilization procedure.

Following the parameters suggested by Decision No. 471/2001 of the European Community (EC, 2001), the surfaces of the scraping knives at time 1 and 2, jowls at time 2, tail at time 1 and 2 and red viscera at time 2, analyzed in this work, presented counts above the allowed for mesophilic aerobic bacteria. For Enterobacteriaceae, the levels were unacceptable in the knives used for the abdominal opening in time 1 and in the removal of red viscera in times 1 and 2.

Also, observe that in the knives of the Scraping, Belly, Tail and White viscera points, there was no increase in the counts of mesophilic aerobic bacteria and Enterobacteriaceae, with the increase in the time of use. However, at these points there was an increase in bacterial counts at time 1, that is, after 1.5 minutes of use, however, at time 2, after 3 min of use, there was a decrease in counts.

Thus, these results demonstrate that the knives used during slaughter operations may become a contamination vehicle, that is, the microorganisms were transferred to subsequent carcasses (Barbosa et al., 2016; Swart et al., 2016). This statement is corroborated by the study by Biasino et al. (2018), when reporting that cross contamination of carcass contact surfaces is a factor that makes the slaughter of pigs a complex process, with a high risk of microbial contamination, making it thus a potential risk to human health.

According to Biasino et al. (2018), the knives used in slaughtering may be highly contaminated, due to the procedures performed with them, such as scraping the surface of the carcass in the scraping, opening the pig carcass and removing the internal giblets and external in the clean zone. Table 4 shows the results of the counts of hygiene indicator microorganisms on nine knives used in the deboning and trimming process of pork cuts.

In the analyzes of mesophilic aerobes, the average variation was between 0.30 and 1.57 log CFU/cm^2 at time 0, between 0.10 and 1.53 log CFU/cm^2 at time 1 and between 0.00 and 1.05 log CFU/cm^2 at time 2. For Enterobacteriaceae, it was absent at time 0 and time 01, while at time 2 the variation was from 0.00 to 0.23 log CFU/cm^2. Of the results obtained in the analyzes for mesophilic aerobes carried out on the boning

knives, 30% presented counts above the standard in comparison with the permitted microbiological levels of Decision 471 of the European Community. For Enterobacteriaceae, 19% of the results showed levels above what is allowed, according to this same legislation.

Table 4. Counts of mesophilic aerobic bacteria and Enterobacteriaceae (mean ± standard deviation), at different times of use of knives used in deboning and trimming pork cuts.

Line knife	Aerobic Mesophiles log UFC/cm²			Enterobacteriaceae log UFC/cm²		
	Time 0	Time 1	Time 2	Time 0	Time 1	Time 2
Belly 01	0.55±0.43	0.63±0.29	0.56±0.40	0.00±0.00	0.00±0.00	0.10±0.14
Belly 02	1.02±0.51	1.53±0.05	0.93±0.77	0.00±0.00	0.00±0.00	0.10±0.14
Belly 03	1.57±1.00	1.19±005	0.91±0.25	0.00±0.00	0.00±0.00	0.00±0.00
Shoulder 01	0.30±0.25	0.36±0.51	0.48±0.36	0.00±0.00	0.00±0.00	0.00±0.00
Shoulder 02	1.15±0.98	0.28±0.40	1.05±0.81	0.00±0.00	0.00±0.00	0.10±0.14
Shoulder 03	0.90±0.67	0.26±0.20	0.89±0.75	0.00±0.00	0.00±0.00	0.23±0.33
Leg 01	1.52±1.23	0.26±0.37	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
Leg 02	0.40±0.38	0.10±0.14	0.82±0.96	0.00±0.00	0.00±0.00	0.10±0.14
Leg 03	1.24±1.43	0.35±0.49	0.48±0.68	0.00±0.00	0.00±0.00	0.00±0.00

* For knives, considering each sample collection date a repetition. Time 0: 0 min. Time 1: 1 hour and 35 min. Time 2: 3 hours and 10 min.

The results of the bacterial counts of the knives at time 0, in deboning, showed high contamination. This indicates that the cleaning procedure is deficient, thus allowing cross-contamination in the cuts performed. The detection of these microorganisms is an indication that the hygienic-sanitary conditions also allow contamination by pathogens (Ferreira & Simm, 2012).

Regarding the boning knives, after cleaning, the counts obtained for mesophilic aerobes are in accordance with the results found by Rodrigues (2019), where they obtained high counts of mesophilic aerobes. Therefore, it indicates a deficiency in hygiene procedures and, because of this, may lead to the formation of biofilms by these bacteria, which need to be treated with care, as it increases the probability of microbial multiplication and makes it difficult to eliminate them in the cleaning process.

Contact with contaminated surfaces may compromise the microbiological quality of food, especially if the heat treatment is not adequate for the inactivation of bacterial cells, which may be present. According to Brazil et al. (2017), despite technological advances in recent years in the meat industry, maintaining hygienic-sanitary control

of equipment and utensils used during processing is still a problem. Equipment and utensils may contaminate food if not properly sanitized, thus reducing product shelf life and safety.

The occurrence of mesophilic aerobic bacteria and Enterobacteriaceae in boning knives corroborates the results found by Secchi, Salazar and Wendt (2015), where high contamination of the knives was observed after two hours of use. Already, Secchi, Salazar and Wendt (2015) indicate that the time of up to two hours to change the knives meets the microbiological standard stipulated by legislation, thus not offering a risk of cross contamination.

According to Choi et al. (2013), the slaughter process has several possibilities of contamination by pathogenic bacteria, with animal skin, water used, equipment and utensils appearing as the major sources of contamination during slaughter. Table 05 shows the average count of hygiene indicator microorganisms at five points in the pig slaughter process.

Table 5. Counts of mesophilic aerobic bacteria and Enterobacteriaceae (mean ± standard deviation) in water and surfaces of slaughter equipment.

Water/Equipment	Aerobic Mesophiles log UFC/cm²	Enterobacteriaceae log UFC/cm²
Scalding tank water	2.81± 0.26	0.00± 0.00
Rehang table	0.69± 0.21	0.00± 0.00
Polisher 01	3.21 ± 0.56	1.46± 0.62
Polisher 02	4.17± 1.52	0.36± 1.00
Polisher 03	3.77± 0.43	1.13± 0.61

In the analyzes of water and equipment surfaces, the average variation was between 0.69 and 4.17 log CFU/cm^2 for mesophilic aerobes and for Enterobacteriaceae, the average variation was between 0.00 and 1.46 log CFU/cm^2. Based on the results of the mesophilic aerobic analyzes carried out on the surfaces in contact with the carcasses, it was found that 80% had counts above the standard, in comparison with the permitted microbiological levels of Decision 471 of the European Community. For Enterobacteriaceae, 60% of the results showed levels above the permitted, according to this same legislation.

Following the parameters of Decision n° 471/2001 of the European Community (EC, 2001), the water from the scalding tank and the polishers analyzed, in this study, presented counts above the allowed for mesophilic aerobic bacteria, while for Enterobacteriaceae, unacceptable levels were detected in the polishers.

During the stages of carcass contact with equipment such as scalding, the rehanging table, the dry polisher, the wet polisher and the polisher after cleaning, the carcasses may become contaminated with feces and bacteria may spread through it and, by subsequent carcasses, in addition to contaminating equipment, facilities and utensils (Busser, Zutter, Dewulf, Houf, & Maes, 2013). Table 06 shows the counts of indicator microorganisms in the carcasses, at seven different slaughter points.

In the carcass analyses, the average variation was between 2.52 and 3.07 log

CFU/cm^2 for mesophilic aerobes and for Enterobacteriaceae, the average variation was between 0.20 and 1.41 log CFU/cm^2. In the step, before the white viscera and after the red viscera, an increase in the count of mesophilic aerobes and enterobacteria was observed, this increase may be correlated with cross-contamination during the manual operation of the removal of the viscera, which occurred through the contact of materials of gastrointestinal origin with the surface of the carcass.

Table 6. Counts of mesophilic aerobic bacteria and Enterobacteriaceae (mean ± standard deviation) in carcasses at different slaughter points.

Carcass	Aerobic Mesophiles log UFC/cm²	Enterobacteriaceae log UFC/cm²
Rehang table	3.01±0.61	1.41±0.56
After polisher 01	3.07±0.53	0.43±0.51
After polisher 02	3.04±0.34	0.57±0.74
After polisher 03	2.59±0.45	0.20±0.35
Before white viscera	2.52±0.63	0.30±0.30
After red viscera	2.92±0.58	0.41±0.71
After final wash	2.59±0.46	0.95±0.50

According to Circular 130/2007, which defines the microbiological standards of pig carcasses, the average results obtained from the count of mesophilic aerobes and Enterobacteriaceae are all within acceptable parameters (MAPA, 2007). Following the EC Regulation 2073/2005 (EC, 2005), there was a count above the allowed for mesophilic aerobes on the surface of the carcasses at the points after polisher 01 and after polisher 02 and for Enterobacteriaceae, the results were in accordance with the acceptable standard.

As can be seen in table 6 in the results of the indicators of carcass hygiene indicators at different times of slaughter, there was, at times, the inversion of carcass contamination results. These results corroborate those found by van der Gaag et al. (2003) and Ducas, Hirano, Nascimento and Moreira (2010), where contamination variations were also observed in different segments of the pig slaughtering process.

This reversal of results may be explained by the variation in operational and personal hygiene conditions, equipment and facilities in force in each establishment, revealing the complexity of slaughter activities and inefficiency of sanitary inspection in the slaughterhouse (Ducas et al., 2010). The results obtained in the present research show that cross-contamination is deduced periodically, on different knives throughout the process, compromising the safety of the carcasses and subsequently of the cuts, which provides support for proposing some interventions in the monitoring of quality indicator microorganisms and hygiene in the pig slaughterhouse.

Analysis of variance revealed no interaction between collection point x time for the mesophilic aerobic (MA) effects of slaughter knives. However, significant main effects were obtained across collection point and time. No variability was identified for the collection points compared to the variable mesophilic aerobes in the carcasses,

on the other hand, there was significance for mesophilic aerobes in the equipment where the collection points were significant.

The correlations for the effects of the observations made on knives used in the slaughter were significant, showing an inverse variable between the collection point and the mesophilic aerobic count, considering that as it advances in the production line, it reduces the count of mesophilic aerobes in the analyzed knife. It was also observed that the increase in the time of use of the knife in the slaughter, increases the microbiological contamination of aerobic mesophiles (Figures 1A and Figure 2).

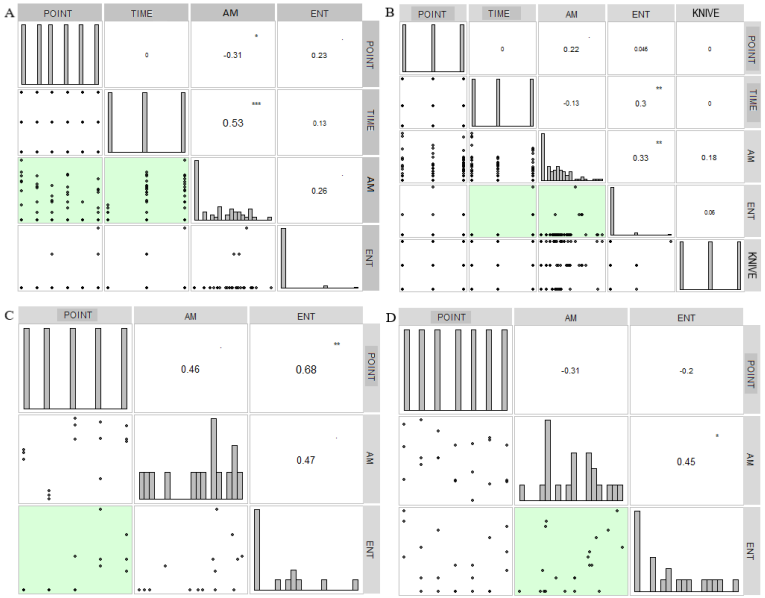

Figure 1. Linear correlation for treatment effects x slaughter knives (A). Correlation for the effects of time and microorganism on the knives used in deboning (B). Correlation for equipment effects (C). Correlation for the effects of pig carcasses at different points of slaughter (D).

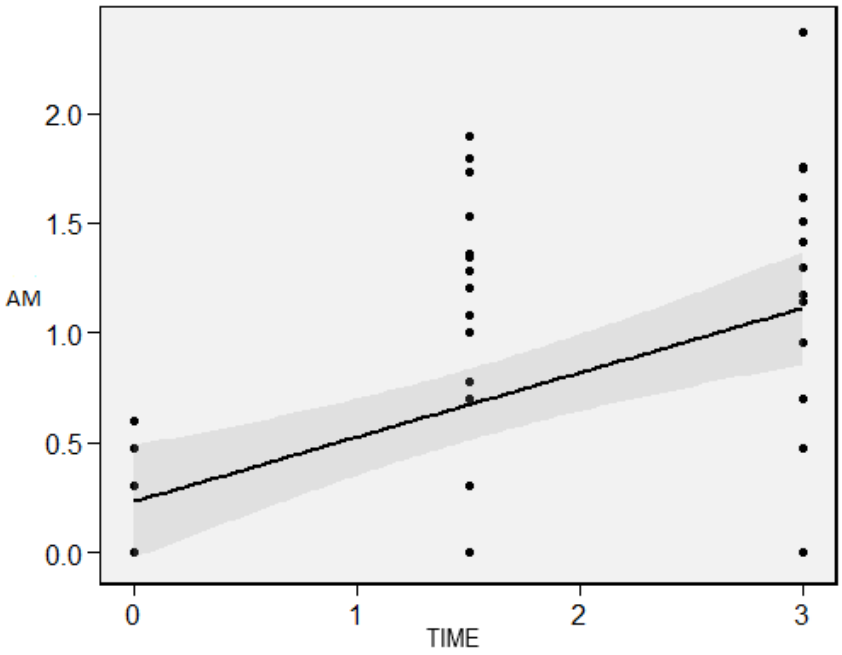

Figure 2. Linear regression trends for the time effects of knives used in slaughter.

The correlations for the effects of the observations made on knives used in deboning are significant at 5% probability by the t test, between the point and the count of mesophilic aerobes, and as the production line progresses, the count of mesophilic aerobes increases. It was also proved that the exposure time is correlated with the increase in the presence of this microorganism. A correlation was also observed between the increase in mesophilic aerobes and Enterobacteriaceae (Figure 1B). Thus, the presence of mesophilic aerobes above acceptable levels indicates that there is a need for greater care regarding the hygienic-sanitary quality of the utensil, in terms of the point x time binomial.

The correlations for the effects of the observations made on equipment used in slaughter were significant, between the equipment and Enterobacteriaceae, with the Enterobacteriaceae count increasing as it progresses in the production line (Figure 1C). Observe in Figure 1D, there is a correlation between the increase in mesophilic aerobes and the increase in Enterobacteriaceae in pig carcasses.

Conclusions

Due to the results presented, it is possible to conclude that the knives used during slaughter operations may become a form of contamination. The presence of mesophilic aerobes above 1 log CFU/cm^2 on the surface of the knives during slaughter and deboning is an indication of a deficiency in their sterilization time and the main factor responsible for contamination during slaughter, among the evaluated points, was the knife of the cleaning, mainly in relation to mesophilic aerobes, while in deboning it was found that the pre-operational cleaning procedure is deficient.

The count above the allowed for mesophilic aerobes, on the surfaces of the boning knife blades after cleaning, is an indication of deficiency in the pre-operational hygiene procedure of these utensils, in the counts of aerobic mesophilic bacteria and Enterobacteriaceae there was at some moments, the increased contamination at different collection points on equipment and carcasses.

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