

## Microbiological quality of meat and fish provided by family farming to school meals

### *Qualidade microbiológica de carnes e pescado fornecidos pela agricultura familiar à merenda escolar*

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**Abstract:** Considering that some products of animal origin supplied for school meals in the municipal network of Francisco Beltrão, PR are from family farming, this research aimed to evaluate the quality of meat products and fish samples supplied by family agroindustry through microbiological analysis, as well as to check the items that assess the hygienic-sanitary conditions of the agribusinesses. The results showed that some samples of meat and tilapia fillet are unfit for consumption. Regarding the checklist, the agro industries of cattle and fish met 85% of the items, while the agro industries of pork met 50% of them. The quality of the meat and tilapia fillet supplied by the family agribusiness to the school supply of the municipal network of Francisco Beltrão can be improved through the search for greater control of the hygienic-sanitary conditions of the agro industries, compliance with good manufacturing practices, and hygiene in food production.

**Keywords:** Microbiological analysis. Hygienic-sanitary conditions. Agro industries.

**Resumo:** Considerando que alguns produtos de origem animal fornecidos para alimentação escolar na rede municipal de Francisco Beltrão, PR são provenientes da agricultura familiar, esta pesquisa teve como objetivo avaliar a qualidade de produtos cárneos e amostras de peixes fornecidos pela agroindústria familiar por meio de análises microbiológicas, bem como verificar os itens que avaliam as condições higiênico-sanitárias dos agronegócios. Os resultados mostraram que algumas amostras de carne e filé de tilápia são impróprias para consumo. Em relação ao *checklist*, as agroindústrias de bovinos e pescados atenderam a 85% dos itens, enquanto as agroindústrias de suínos atenderam a 50% deles. A qualidade da carne e do filé de tilápia fornecidos pela agroindústria familiar ao abastecimento escolar da rede municipal de Francisco Beltrão pode ser melhorada por meio da busca de maior controle das condições higiênico-sanitárias das agroindústrias, cumprimento de boas práticas de fabricação e higiene na produção de alimentos.

**Palavras-chave:** Análise microbiológica. Condições higiênico-sanitárias. Agroindústrias.

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## 1 Introduction

School feeding is one of the most important public policies that seek to ensure food and nutritional security for schoolchildren (Oostindjer *et al.*, 2017). The National School Feeding Program (PNAE) aims to encourage growth, development, learning, and school performance of students seeking to contribute to the formation of healthy eating habits (Fundo Nacional de Desenvolvimento da Educação [FNDE], 2017).

Family farming is responsible for producing the largest amount of food consumed in the country, generating jobs and income, using alternative, efficient, and profitable forms to transport its production and has a key role in food security and nutrition of the population (Schröetter, 2011; Oliveira, 2015). In 2009, PNAE published Resolution 38, establishing that 30% of the funds transferred by the National Education Development Fund (FNDE) be directed towards the purchase of food products acquired from family farming (FNDE, 2009).

Food security is a global health goal, therefore, it is necessary that microbial pathogens be detected in foods to prevent diseases (Gokulakrishnan & Vergis, 2015). The food products purchased for school meals must provide health and nutritional quality. Regarding the products of animal origin, the legislation provides for parameters of physical and sanitary structure so that processed foods can be marketed (Brasil, 2017).

Thus, the food supplied by family farming, as well as other food supplied by large companies, must have an acceptable contaminant level, whether physical, chemical, or biological agents, thus avoiding possible foodborne diseases (DTA) (Brasil, 2016).

Between 2009 and 2018 a total of 6,809 DTA outbreaks and 634,568 people were exposed, while 120,584 became ill (Brasil, 2019). Numerous meals are produced in schools and daycare centers, and it is common for outbreaks of DTA to occur in these places. Thus, good food handling practices must be followed to avoid possible food contamination (Firmo, 2010).

According to the Paraná Institute for Economic and Social Development (IPARDES), 15,080 children were enrolled in 2018 in the municipality of Francisco Beltrão, located in the southwest of the state of Paraná, Brazil. The Municipal Department of Education, through the Department of School Meals, provides for the purchase of food from Family Farming, using a resource that the FNDE sends to school meals for these acquisitions, and also employs the municipality's own resources for supplement (Instituto Paranaense de Desenvolvimento Econômico e Social [IPARDES], 2018).

Among the products of animal origin purchased by the entity responsible for the school feeding in Francisco Beltrão, the highlights are the frozen meat and tilapia fillet. Thus, it is a concern of the Municipal Education Secretariat and of the School Food Department of the Municipality of Francisco Beltrão to know and monitor the quality of the food offered for school feeding in the municipality.

Therefore, this research aimed to verify the quality of meat and tilapia fillet samples provided by the family agribusiness for school feeding in the municipal school system of Francisco Beltrão, PR through microbiological analysis of beef (chunk and ground), pork, chicken, beef liver, and tilapia fillet, as well as verification of the good practices of manufacturing and the quality of water used by agro-industries which handle these foods.

## 2 Materials e Mehtods

Microbiological testing of meat products samples and fish provided by family agro-industries to school feeding in the municipality of Francisco Beltrão from August to October 2017 was done to verify the standards required by resolution RDC No 12 of January 2<sup>nd</sup>, 2001. The analyzes were carried out at the Microbiology laboratory of the Universidade Estadual do Oeste do Paraná, UNIOESTE, Campus Francisco Beltrão.

The samples came from a pork producer, a tilapia fillet producer, and a beef producer. Chicken meat and beef liver were purchased at the local market.

Deliveries were made every 15 days to schools and daycare centers, and three samples were taken of each type of meat (pork, beef, ground beef, chicken, and beef liver), and tilapia fillet at intervals of 30 days.

In this way, 6 samples were analyzed in triplicate. The microbiological analyzes performed were investigation for *Salmonella* spp. for pork, beef in pieces, ground beef, beef liver, and tilapia fillet. For chicken samples, the coliform count was performed at 45° C, and for tilapia fillet the coagulase-positive *Staphylococcus aureus* count was evaluated.

The method described by Silva, Junqueira and Silveira (1997) was used for the detection of *Salmonella* spp. even in extremely unfavorable cases.

The method described in Normative Instruction No 62 of the Ministry of Agriculture, Livestock, and Supply (Brasil, 2003) was used to count thermotolerant coliforms (45° C).

The Count of coagulase-positive *Staphylococcus aureus* was performed through the method described by Silva *et al.* (1997) aiming to identify the hygienic-sanitary quality control in the production process of tilapia filet.

A checklist was also applied according to RDC No 275/2002 and adapted by Pertille, Zavaschi and Badaró (2016) to verify the facilities, equipment, water, and raw material used in the process, vector and pest control, and management of waste generated from the meat and tilapia fillet agro-industries that supply these foods for school feeding in the municipality of Francisco Beltrão, PR.

The reports of the last physical-chemical and microbiological analysis of water samples used by agribusinesses and carried out in a private laboratory were analyzed.

### 3 Results

#### *Microbiological analysis of meat*

*Salmonella* spp. was researched for pork. Only in sample number four *Salmonella* spp. was detected in 25g of the product (Table 1).

The RCD Resolution No 12/2001 of ANVISA defines the absence of *Salmonella* spp. for chilled or frozen pork in 25g of a sample as a microbiological standard. As it was observed, sample four presented contamination by *Salmonella* spp. in disagreement with the current legislation and was unfit for consumption (Brasil, 2001a).

**Table 1.** Results of the analysis for the presence of *Salmonella* spp. in pork samples.

Samples	<i>Salmonella</i> spp.
Pork Meat1	Absence in 25g
Pork Meat2	Absence in 25g
Pork Meat3	Absence in 25g
Pork Meat4	Presence in 25g

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As noted in Table 2, beef was supplied in two forms for school meals, in pieces and ground, and for both types, a microbiological analysis of *Salmonella* spp was done. Only sample three of the beef piece showed contamination, in the other samples no *Salmonella* spp was found in 25g.

**Table 2.** Results of the analysis for the presence of *Salmonella* spp. in beef samples.

Sample	<i>Salmonella</i> spp.
Beef1	Absence in 25g
Beef2	Absence in 25g
Beef3	Presence in 25g
Ground Beef1	Absence in 25g
Ground Beef2	Absence in 25g
Ground Beef3	Absence in 25g

Concerned about the nutritional value of school meals in Francisco Beltrão, PR, the nutritionist requested the inclusion of beef liver in the menu of the Municipal Early Childhood Education Centers (CMEIs) in the municipality. As it is not offered by the family agroindustry, it is purchased from the supermarket that has the lowest price, due to the public bidding process.

Of the three samples analyzed, as shown in Table 3, one sample showed the presence of *Salmonella* spp. in 25g, an unsatisfactory result for the standard established by RDC No 12/2001 of ANVISA (Brasil, 2001a).

**Table 3.** Results of the analysis for the presence of *Salmonella* spp. in beef liver samples.

Sample	<i>Salmonella</i> spp
Beef Liver1	Absence in 25g
Beef Liver2	Presence in 25g
Beef Liver3	Absence in 25g

The chicken meat was also supplied by the supermarket that won the bidding, as there is no offer from the family agribusiness. The cut provided is the thigh and leg quarter. The result was negative for the count of thermotolerant coliforms for all the samples (Table 4).

**Table 4.** Results of the analysis of thermotolerant coliforms in chicken meat samples.

Samples	Thermotolerant coliforms
Chicken Meat1	<10 <sup>1</sup> UFC/g
Chicken Meat2	<10 <sup>1</sup> UFC/g
Chicken Meat3	<10 <sup>1</sup> UFC/g

For the tilapia fillet samples, coagulase-positive *Staphylococcus aureus* and *Salmonella* spp., no sample had *Staphylococcus*, but two of the four samples were contaminated with *Salmonella* spp. (Table 5).

**Table 5.** Results of the analysis for the presence of coagulase-positive *Staphylococcus aureus* and *Salmonella* spp. in tilapia fillet samples.

Samples	Coagulase-positive <i>Staphylococcus</i>	<i>Salmonella</i> spp.
Tilapia fillet1	<10 <sup>1</sup> UFC/g	Absence in 25g
Tilapia fillet2	<10 <sup>1</sup> UFC/g	Presence in 25g
Tilapia fillet3	<10 <sup>1</sup> UFC/g	Absence in 25g
Tilapia fillet4	<10 <sup>1</sup> UFC/g	Presence in 25g

In the Resolution RDC No 12/2001, the standard required for *Salmonella* spp. in chilled, frozen, or fresh fish is the absence in 25g of the sample (Brasil, 2001a). In this work, samples 2 and 4 are not in compliance with the resolution, so they are unsuitable for consumption. Regarding the result of coagulase-positive *Staphylococcus aureus*, all samples are in compliance with the current resolution.

## Checklist

With regard to the result of the checklist application to verify the hygienic-sanitary conditions of the meat-producing agro-industries (beef and pork) and the tilapia fillet, the percentage of compliance with the items is shown in Table 6.

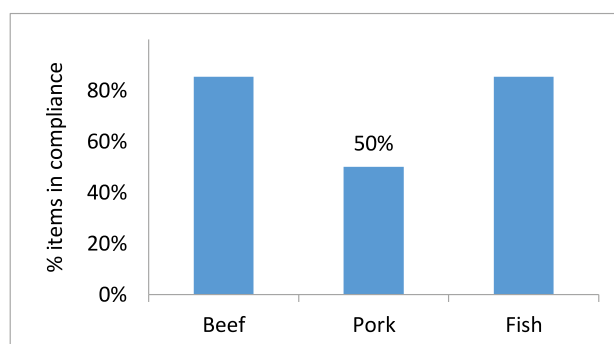
**Table 6.** Percentage of compliance for the items of the RDC No 275/2002 per block, in the agro-industries of bovine, swine, and fish.

Blocks (number of items)		% of items in compliance with the cattle agroindustry	% of items in compliance with the swine agroindustry	% of items in compliance with the fish agroindustry
Facilities	50	76.92	51.28	87.17
Equipment	9	85.71	47.61	95.23
Vectors and Pests	5	80	20	80
Water Supply	4	100	75	100
Waste management	3	100	33.33	66.66
Handlers	16	93.33	80	80
Raw material	15	93.33	26.66	73.33

In the total of items met by the researched agro-industries referring to the hygienic-sanitary conditions required by the RDC No 275/2002 of ANVISA, the beef and fish agroindustry met more than 85% of the items, while the swine agroindustry met only 50% of the items, as shown in Figure 1.

When the reports of the physical-chemical and microbiological analyzes of the agro-industries' water were verified, we observed that in the agro-industries of cattle, pig, and fish, all the items charged in Consolidated Ordinance No 5, of the Ministry of Health, of 09/28/2017, are in accordance.

**Figure 1.** Total percentage of items in compliance with agroindustries that supply meat products and fish to school meals



## 4 Discussion

### *Microbiological analysis of meat*

Checking the quality of fresh pork sold in public markets in the micro-region of Brejo Paraibano, it was observed contamination by *Salmonella* spp. in five of the 19 samples analyzed, corresponding to 26.32% (Souza, 2012). This value is very close to what was found in this study, in which the percentage corresponds to 25% of the samples that do not meet RDC No 12/2001 (Brasil, 2001a). As for the beef analysis, Signarini (2004) found contamination in 15% of the beef samples after deboning in the research of *Salmonella* spp. which shows similarity to the result found in the research shown here, since we detected 17% of the samples with the presence of *Salmonella* spp.

Velho *et al.* (2015) detected the presence of *Salmonella* spp. in beef in 88% of the public market boxes and 63% of the supermarkets evaluated. Besides, the presence of coliforms at 35° C was found in 100% of the establishments analyzed, and coliforms were found at 45° C in 93.75%. Similarly Antunes, Oliveira, Salema and Souza (2016) found 86.7% of fresh beef samples sold in the municipality of Vale do Jequitinhonha, MG, Brazil, with positive results for total coliforms, ranging from <3 NMP/g to 1100 NMP/g, and the average was 222 NMP/g.

But the results obtained by Becker and Kiel (2011), who carried out an analysis of *Salmonella* spp., mesophilic aerobic, total and fecal coliforms, molds and yeasts in five samples of fresh beef from supermarkets of Cascavel, PR, Brazil, in only one sample of 25g of the product the presence of *Salmonella* spp. was detected. However, the Brazilian legislation is incomplete for the researched product, since all the samples presented contamination by mesophilic aerobes, total coliforms, thermotolerant, molds and yeasts, but there is no microbiological standard for these microorganisms. The results were similar to those shown in the research with the beef supplied by the family agribusiness to school feeding.

Lundgren, Silva, Maciel and Fernandes (2009) pointed out a high total count of aerobic mesophilic bacteria in the 10 samples of beef sold in some establishments in the city of João Pessoa, PB, Brazil. Total coliforms ranged from  $2.4 \times 10^2$  to  $> 2.4 \times 10^3$  NMP/g. However, the results of the analysis of thermotolerant coliforms were between  $9.3 \times 10$  and  $> 2.4 \times 10^3$  NMP/g. The coagulase-positive *Staphylococcus* count was also high and ranged from <10 to  $1.8 \times 10^6$  CFU/g. The presence of *Salmonella* spp. was not detected in any of the samples, differing from this study.

Through the results obtained in the research by Stochero, Carlesso and Smaniotto (2013), it can be concluded that the hygienic-sanitary conditions of ground beef sold in two retailers (supermarkets) in Palmeira das Missões, RS, Brazil are impaired and can be improved with the implementation of programs such as Good Manufacturing Practices.

In the research carried out by Ferreira (2008), the results found for the analysis of ground beef in Uberlândia, MG, Brazil, were that 100% of the samples were contaminated by *Staphylococcus* sp, plus high counts of mesophilic bacteria and total coliforms and *E coli*, which suggest poor equipment hygiene and the risk of cross contamination, respectively. In contrast, the results of the research by Ferreira and Simm

(2012) showed that among the six samples of ground meat supplied in a butchery in Pará de Minas, MG, Brazil, one (16.67%) presented *Salmonella* spp., proving to be inappropriate for consumption. These results differ from this research, where this pathogen was not seen in any of the ground beef samples.

In the analysis of beef liver, Tanaka, Gomes, Matheus and Leite (1997) observed the absence of *Salmonella* spp. in the three samples analyzed in Bauru, SP, however, 33.3% of the samples showed contamination by thermotolerant coliforms and *E. coli*.

It was different when Silva (2002) researched beef liver samples for aerobic mesophilic microorganisms, molds and yeasts, total coliforms, and thermotolerant. For aerobic mesophiles, the results ranged from  $2.7 \times 10^4$  to  $2.9 \times 10^4$  CFU/g. For molds and yeasts, it was found a variation of  $6.3 \times 10^4$  to  $6.7 \times 10^4$  CFU/g. As for total coliforms and thermotolerant, it was from  $4,6 \times 10^3$  to  $1.1 \times 10^4$  CFU/g and  $<0,3$  UFC/g, respectively.

With regard to the analysis of chicken meat, Souza (2014) found no contamination by thermotolerant coliforms which is what ANVISA determines through Resolution RDC No 12/2001, the maximum allowing the count of  $10^4$  CFU/g. For mesophilic microorganisms, a count of up to  $5.2 \times 10^4$  CFU/g was found and a sample with the presence of *Salmonella* spp.

Among the results found by Oliveira and Salvador (2011), when quantifying *Staphylococcus* sp., the count was between  $2.4 \times 10^2$  CFU/g and  $2.35 \times 10^4$  CFU/g. In the analysis of total coliforms, it was observed that all samples are in accordance with the established by RDC No 12/2001. In the research of *Salmonella* spp., 60% of the samples contaminated with this bacterium were found, which presents an unsatisfactory result even with RDC No 13/2001 which establishes the inclusion of labels on the packaging of meat and chicken giblets to clarify to the consumer that the food may be contaminated with *Salmonella* spp. (Brasil 2001b).

The results of the research in this work are similar to the works carried out by Souza (2014) and Oliveira and Salvador (2011), as all samples are in accordance with RDC No 12/2001 of ANVISA (Brasil, 2001a) and, therefore, suitable for consumption.

The tilapia fillet analyzes showed 50% of the samples contaminated by *Salmonella* spp. in this study. The *Salmonella* spp. can be eliminated at the cooking or frying of the tilapia fillet. However, the main problem is the inadequate preparation of the food, both due to the low quality of the raw material and the lack of hand hygiene and the tools used. Food handlers must be careful with skin lesions or hand injuries, as during preparation they can contaminate food and cause illness to consumers (Sato and Kussaba, 2014).

In the work of Barbosa (2015), the microbiological analysis of filets of Mapará (*Hypophthalmus edentatus*), Arunã (*Osteoglossum bicirrhosum*), and Pirarara (*Phacetocephalus hemiiopterus*) did not show any *Salmonella* spp. or *Escherichia coli* in 25g for the three samples. The count of coagulase-positive *Staphylococcus aureus* showed nothing in the three samples either, but for total coliforms and thermotolerant coliforms the result was  $0.9 \times 10^2$  NMP/g Marapá,  $1.1 \times 10^2$  NMP/g Arunã,  $2.3 \times 10^2$  NMP/g Pirarara,  $<3$  NMP/g Marapá,  $<3$  NMP/g Arunã, and  $2.3 \times 10^2$  NMP/g Pirarara, respectively. The presence of bacteria in food products can make it unsuitable for consumption, establishing a serious problem for public health (Barbosa, 2015).



## Checklist

For the product offered to the consumer to be safe, it is important that the raw material is of good quality and that hygienic sanitary care is observed during slaughter. These precautions were evaluated by Antunes *et al.* (2016) in the bovine agribusiness studied where flawed items were identified, mainly related to the facilities, where 23% of the items did not meet.

In the work of Pertille *et al.* (2016), the hygienic-sanitary conditions of the same agro-industries researched by this work were verified from September 2014 to September 2015. With regard to facilities, the swine agroindustry was the one that reached the lowest percentage of items that met the requirements, that is, 46.15%, which is now repeated because, in this study, the checking of the installation items for this agroindustry met 51.28%, while the others met 76.92% in the bovine agroindustry and 87.17% in the fish agroindustry.

Regarding the equipment, comparing the data found by Pertille *et al.* (2016) two years ago, there was an improvement of these items, mainly by the fish agroindustry which met 45.45% and in 2017 met 95.23% of the items referring to equipment. Talking to the agroindustry manager, the information obtained was that investments in more modern equipment and the training of handlers helped this improvement.

For the data referring to vectors and pests, we can see that the swine agroindustry met only 20% of the items, showing a significant drop if we consider that in the work of Pertille *et al.* (2016) they met 80%. In the water supply block, the swine agroindustry that met only 33.33%, showed a significant improvement by reaching 75%.

Regarding the raw material and waste management items, there was a drop in accomplishing the items, with emphasis on the swine agroindustry that met 100% of the raw material items, while in this study it met only 26.66%. For waste management, the fish agroindustry also showed a decrease by accomplishing 66.66%, while in the research by Pertille *et al.* (2016) it accomplished 100%.

Handlers are essential parts of the food industry. They must act safely and have the know-how that enables them to carry out their tasks successfully. In this regard, the data obtained in this research hardly differ from the data found by Pertille *et al.* (2016) since two years ago the average success in accomplishing the items related to handlers by the researched agroindustries was 77.77% and now they met 84.44%.

The results found by Fonseca (2004) when applying the checklist of good manufacturing practices in a Refrigerated Distribution Center that receives, stores, and sell beef and cattle innards are that the facilities items are in accordance with Resolution No. 275/2002 ANVISA but the items for cleaning facilities and equipment showed non-conformities.

Using the checklist, Velho *et al.* (2015) classified 50% of supermarkets as regular and 50% of boxes of public markets received a bad rating. The fresh beef sold at the evaluated locations comes with microbiological contamination and despite the fact that supermarkets have better hygienic-sanitary conditions than public markets, these were still unsatisfactory, requiring the adoption of preventive measures to avoid this type of contamination.

Unlike the results found in the previously reported study, this study found the presence of *Salmonella* spp. in just one sample of beef. When observing the results

of the checklist, it was seen that the agroindustry that supplies beef for school meals in Francisco Beltrão, PR meets 85% of the verification items of RDC No 275/2002 of ANVISA (Brasil, 2002).

In the research by Costa *et al.* (2013), 80.95% of the surveyed establishments had low compliance to the evaluated items where 19.05% had medium approval, and none of the mini-markets was able to comply with most of the items. Therefore, greater monitoring by the health inspection organs and attention on the part of the owners regarding compliance with inspection requirements is necessary.

Observing the total of items met in the verification of the hygienic-sanitary conditions of the researched agroindustries and comparing them with what was found by Pertille *et al.* (2016), we point out the decrease in the total number of items in compliance with the swine agroindustry from 61.17% to 50%, and the increase in the total amount of items in compliance with the cattle agroindustry, which went from 82.52% to 85.29%. The fish agroindustry increased from 79.61% to 85.29%, indicating that there are several points to be improved, always aiming at the quality and safety of the food provided for school meals.

## 5 Conclusion

In light of the present study, it was possible to identify that the quality of the meat and tilapia fillet supplied to school meals is closely linked to the hygienic-sanitary conditions of the pork, cattle, and fish agroindustries. The high counts for enterobacteria suggest that besides poor hygiene, the agroindustries is not using sanitizers that would efficiently eliminate these microorganisms.

In view of all the above considerations, it can be said that the quality of the meat and tilapia fillet provided by the family agroindustry to the school supply of the municipal network of Francisco Beltrão, PR can be improved with the search for greater control of the hygienic-sanitary conditions of the agroindustries.

## 6 Conflict of Interest

The authors declared that they have no conflict of interest.

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