

Quality Economic Losses in Brazil's Pork Industry

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Abstract. European Union, USA and Brazil respond to 74% of pork carcass production. However, the productivity is affected by quality issues in production process, pre-handling logistics and transformation process. The objective of this paper was investigated the causes of Brazil's pig carcass condemnation and calculate its respective costs. A descriptive statistical analyzes was performed using data between 2010 and 2014 and costs are calculated comparing losses with pork price in the Brazilian market, in US dollars. The results showed that cost of losses for Pork Industry were estimated in US\$ 27.827 million per year.

Keywords: Pork supply chains, Food quality management, Food losses.

1 Introduction

Quality management in Brazilian pork production has developed gradually over the last five decades. In Brazil, food meat quality is ensured by Brazil's Federal Service Inspection (S.I.F.) that was founded in 1919 [1]. The S.I.F is managed by Brazil's Ministry of Agriculture, Livestock and Food Supply (MAPA), which establish rules, requirements, practices and procedures to protect health and control of diseases in products of animal origin [1]. Nonetheless, product quality needs to be analyzed with a wide view to ensuring food safety and reducing food losses.

Therefore, the food quality management system (FQMS) was developed with the purpose of responding to requirements from consumers about safety, origin and how food is produced [2]. According to Dora et al., quality management has significantly grown in the food sector due to increased consumers' expectations, governmental regulations and the intensive competitive market [3]. Despite these initiatives, quality issues in pork supply chains arise because quality is assessed through its effects over the products instead of consequence of process result. So, it's difficult to identify the real causes of quality problems in the pork industry.

In 2014, the world produced 111,458 million metric tons of pork carcass, where European Union, USA and Brazil responded for 74% [4]. Certainly, these numbers could be higher with an efficient quality management systems adopt in farm, pre-handling logistics and the slaughterhouses process. Moreover, the improve of process could reduce these food losses and contribute with the challenge of the FAO of reduce food waste and food losses [5].

The purpose of this study is find and classify the main causes of pork carcass condemnation to establish the economic losses of the pork industry due to quality issues in farm, pre-handling logistics and slaughterhouses process. Our hypothesis is that a quality management system could be reduce these food losses and guarantee food safety.

2 Methodology

To respond to purpose of this study of identifying the main reasons of condemnation of animals by S.I.F in the Brazilian pork industry, the first step was identifying the causes of condemnation of animals following the rules established by S.I.F., Table 1. We used a database provide by an Information System of Ministry of Agriculture, Livestock and Food Supply that registered all of the causes of animal's condemnations and related in a database [6].

Table 1. Causes of pork carcass condemnation between 2010 to 2014.

Steps	Procedure	Condemnation
1	Pigs' reception	Pigs dead on arrival; carcass broken; severe injuries; signal of stress (pigs fatigued)
2	Pigs' cleaning	Pigs no cleaning before slaughter process are rejected by S.I.F.
3	Stunning	The incorrect stunning process applied cause severe injury in carcass.
4	Cupping	The incorrect cupping process applied cause severe injury in carcass.
5	Scalding	Scalding excessive
6	Depilation	Severe injuries in carcass
7	Evisceration	Evisceration delayed cause carcass contamination. After the evisceration process, parts are inspected by S.I.F. and if identified some kind of disease or parts nonstandard of quality, the parts are rejected by S.I.F.
8	Housing court	All carcass is inspected by S.I.F and if identified some kind of disease or carcass nonstandard of quality, the carcass is rejected by S.I.F.
9	Refrigeration	S.I.F. control the quality of products on refrigeration room and inspected before to release to commercialization.
10	Cutting and deboning	All cutting is inspected by S.I.F and if identified some kind of disease or cutting nonstandard of quality, the parts cutting are rejected by S.I.F.

A descriptive statistical analyzes was performed using data between 2010 and 2014. To do so, we standardized data with a MS excel sheet and process the Pareto analysis. We calculated the economic losses using Pareto analysis, rule 80/20. Thus, we find out that 20% carcass pork parts are responsible by more than 80% of rejections. On the other hand, to establish the weight per unit and price per unit to estimate the losses, we conducted a price research market in Supermarkets, Local Butcher Shops and Free Street Market in São Paulo city, Brazil and convert to US dollars.

To determine the total losses of pork industry in weight (kg) and in monetary (US\$), we applied the Equation 1 and 2, respectively.

$$TLK (kg) = QUR \times UW \quad (1)$$

$$TLD (\$) = TLK \times PK \quad (2)$$

Where,

TLK = Total losses in kilogram,
 QUR = Quantity of units reject,
 UW = Weight of each unit,
 TLD = Total losses in US dollars,
 PK = Price per kilogram.

3 Results and Discussion

Our results showed that during 2010 to 2014, the volume of carcass pork and its parts condemned by S.I.F. was 172,35 million units (average = 43 million units/year). This total 73.9% were associated with South region, 15.4% with Southeast and 10.2% with Midwest [6]. Moreover, 91.7% of all pigs condemned were totally rejected and 8.3% were reused to manufacture products. It is important pointed out that parts of carcass reused by pork industry are free from disease. Usually, these parts are condemned by S.I.F. due to Market patterns.

The main parts of the carcass rejected by S.I.F. during 2010 to 2014 were related to lung with 31.3%, reins (28.3%), liver (14.7%), heart (8.1%), bowel (5.6%), spleen (3.5%), tongue (2.7%) and others, Figure 1.

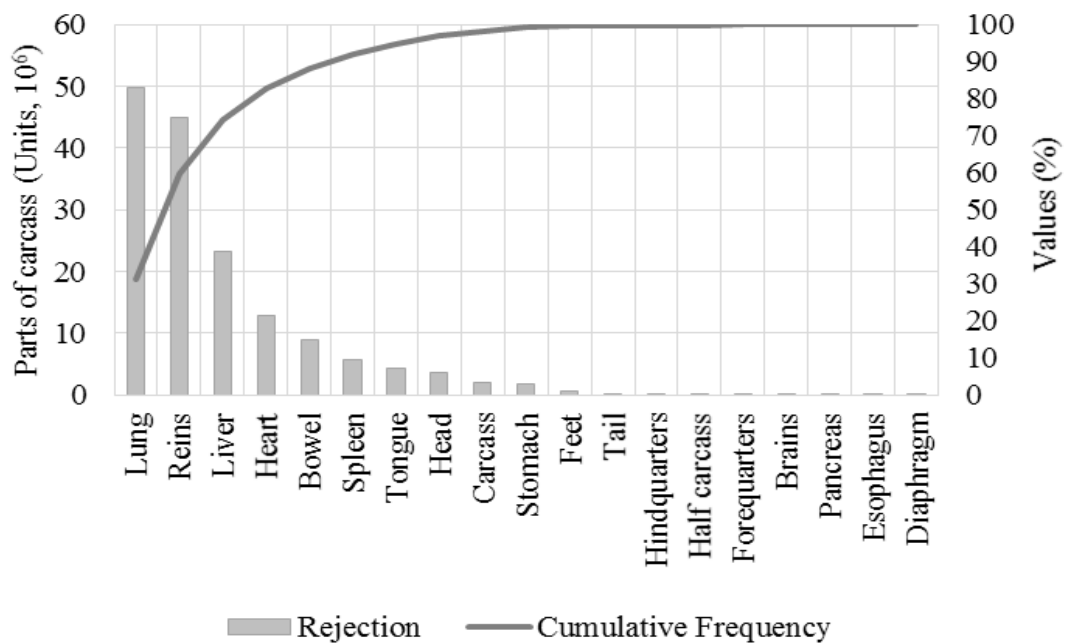


Figure 1. Volume of the main parts of carcass rejected by S.I.F. during 2010-2014 [6].

In our analyzes, we considered the Pareto method and hence the four main park parts are chosen because they represent more than 80% of carcass losses on Brazilian pork industry, as can be seen in Table 2.

Table 2. Economic Losses estimated to pork industry base on the pork products inspected by S.I.F. and rejected during 2010 to 2014 (Million / US\$).

Parts of Carcass	Parts ⁺ (million, units)	Total weight* (million, kg)	Unitary price § (US\$/kg)	Total losses & (million, US\$)	Average losses / year [§] (million, US\$)
Lung	49.69	19.879	1.55	30.813	7.703
Reins	44.87	8.974	1.55	13.910	3.477
Liver	23.36	39.713	1.55	61.556	15.389
Heart	12.97	3.244	1.55	5.028	1.257
Total	130.89			111.309	27.827

+Quantity of units during 2010-2014, million. *Results obtained from Equation 1. §Average unit price estimate, per kilo (US\$); &Results obtained from Equation 2. \$Results of the Total Losses by year analyzed, million (US\$). Source: Adapted from [1], [7] and [8].

Considering these products with more impact on losses, the pork industry showed an estimated economic loss of the US\$ 111.309 million during period analyzed 2010-2014. According to Fruet et al. the

economic losses were estimated at almost 3,100 dollars, considering the number of slaughtered pigs of 6,193, by one pork industry in Santa Maria, Rio Grande do Sul state [8].

The main reasons for the rejection of pork carcass or its parts by S.I.F were contamination (24.3%), urinary cyst (9.3%), nephritis (9.1%), pneumonia (7.7%), congestion (6.5%), emphysema (5.6%), so on [6], Figure 2.

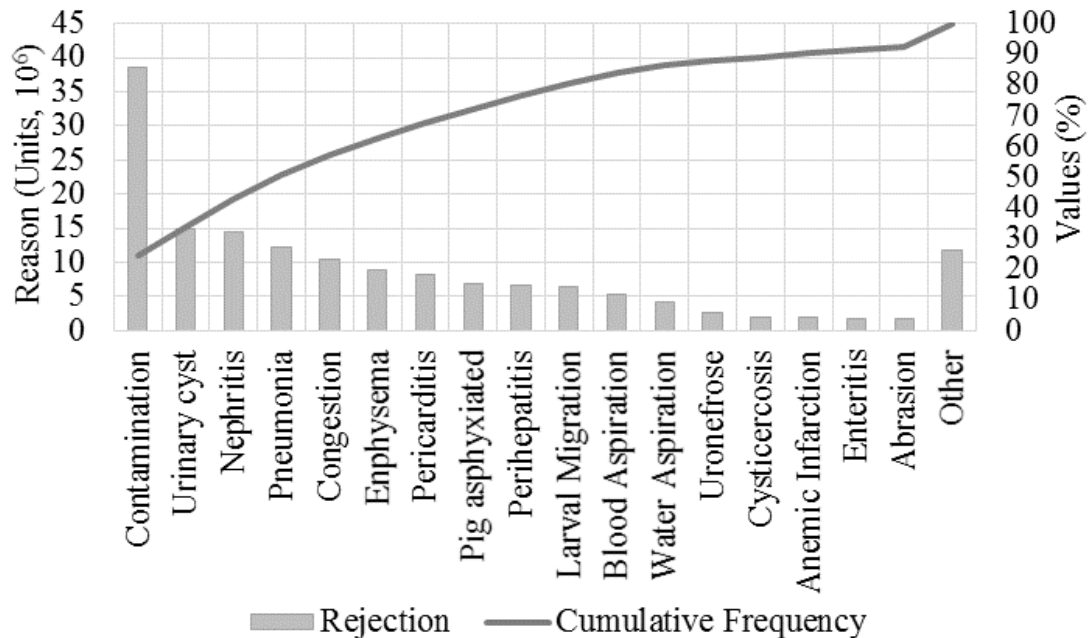


Figure 2. Main reasons of the pork products were rejected by S.I.F. (2010-2014) [6].

Several reasons contribute to condemnation of the pork products over the last four years and its effect in the pork industry. These reasons arise during pig production (farm), pre-slaughter transportation and slaughter process. The pig production losses are associated with diseases that affect directly technical results and economics, such as mortality rate and productivity rate [9].

Losses associated with pre-slaughter logistics occur due to animal stress, such as bruises, traumatic injury, dead on arrival and carcass contamination. In the slaughterhouse the problems were associated with evisceration delayed, scalding excessive and also carcass contamination due to application of the incorrect process.

The main reason to pork carcass condemnation are lung (23.1%), pancreas (28.1%) esophagus (23.3%) and diaphragm (28.4%). These condemnations are related to pneumonia. At the same time 32.5% rejection by reins refers to urinary cyst; 27.7% of liver refers to perihepatitis; 62.4% of heart is related to pericarditis. After, 65.3% of bowel, 66.3% of spleen, 89.2% of tongue, 77.2% of stomach, 56.5% of feet, and 53.8% of tail were associated to contamination. Afterwards, 32.4% of carcass and 34.1% of half-carcass refers to question of abrasion; 48.6% of hindquarter were related with nephritis; and finally 76.9% of the rejection of forequarters and 62.6% of brains were associated to other sanitary question, such as pleurisy (44%) and lymphadenitis (21.3%), respectively, Table 3.

It is important pointed that the meat quality is determined by technological, hygienic and sanitary processes applied during Slaughter [10]. Welker et al. report that of the food contaminated 36% refers to meat products, following by pre-cooked food and salads. Concerning meat products 39% were associated with beef, 30% to poultry, 17% to embedded products and 14% related with pork and fish [11].

The meat is a food susceptible to microbial contamination because of have nutrients (proteins) and high water activity, and low acidity that offer an adequate condition to growth of microorganisms. Thus the hygienic during industry process is essential to guarantee the products health [10] and [12]. In addition, adequate storage and transportation with control temperature are prior to product safety.

Table 3. Percentage of Losses to Brazilian pork supply chain, by main reason of rejection named by S.I.F. (2010-2014).

Parts of carcass*	CO	UC	NEP	PNU	COG	EPA	PCD	PAS	PHP	LRM	BAS	WAS	URO	CIT	AIN	ENT	ABR	OTH
Lung	7.5	0.01	-	23.1	9.2	17.7	0.07	13.7	0.01	0.01	10.4	8.3	0.01	-	-	0.01	1.3	8.1
Reins	17.1	32.5	31.3	0.25	7.01	-	-	0.01	0.04	0.11	-	-	5.6	0.02	4.1	0.06	0.04	1.4
Liver	17.6	0.08	0.29	0.24	8.24	0.01	0.14	0.01	27.7	27.5	-	-	-	8.14	0.01	0.05	0.06	9.7
Heart	31.7	-	-	0.55	0.06	0.22	62.4	0.02	0.3	0.01	-	-	-	-	-	0.04	1.7	2.89
Bowel	65.3	1.5	2.3	0.7	0.4	0.02	0.03	0.02	0.01	0.2	-	-	0.08	-	0.07	18.4	0.3	10.6
Spleen	66.3	0.04	0.03	0.8	12.6	-	-	0.03	0.01	0.08	-	-	-	-	0.01	0.18	0.87	19.02
Tongue	89.2	-	-	2.1	0.08	0.2	0.08	0.06	0.06	0.01	-	-	-	-	-	0.13	0.05	7.98
Head	84.27	-	-	1.93	0.01	0.01	0.04	0.07	-	-	-	-	-	-	-	0.15	0.04	13.45
Body carcass	18.43	1.53	2.6	5.14	0.01	-	0.03	0.01	-	0.01	-	-	-	-	-	0.52	32.43	39.25
Stomach	77.21	0.09	0.06	1.84	0.1	0.01	0.01	0.15	0.01	0.03	-	-	-	-	0.04	2.6	0.28	17.55
Feet	56.5	-	-	9.6	0.17	0.36	-	1.09	-	-	-	-	-	-	-	3.28	-	28.94
Tail	53.83	-	0.39	12.88	-	-	0.01	1.66	-	-	-	-	-	-	-	2.83	0.01	28.36
Hindquarters	4.56	4.79	48.65	0.04	1.50	-	-	-	-	-	-	-	0.24	-	0.12	-	0.05	40.04
Half carcass	28.92	-	-	4.79	-	-	0.01	-	-	-	-	-	-	-	-	0.05	34.11	32.09
Forequarters	22.32	-	-	0.11	-	0.38	-	-	-	-	0.04	-	-	-	-	-	0.23	76.9
Brams	16.25	-	-	16.68	0.11	-	0.08	3.98	-	-	-	-	-	-	-	0.26	0.03	62.6
Pancreas	7.95	-	-	28.19	-	1.2	0.14	5.67	-	-	-	-	-	-	-	0.47	0.01	56.35
Esophagus	17.2	-	-	23.39	0.01	-	-	5.8	-	-	-	-	-	-	-	0.88	0.02	52.57
Diaphragm	1.06	-	-	28.45	-	-	0.05	7.49	-	-	-	-	-	0.01	-	0.02	0.03	62.9

CO = Contamination; UC = Urinary cyst; NEP = Nephritis; PNU= Pneumonia; COG = Congestion; EPA = Enphysema; PCD = Pericarditis; PAS = Pig asphyxiated; PHP = Perihepatitis; LRM = Larval Migration; BAS = Blood Aspiration; WAS = Water Aspiration; URO = Uronefrose; CIT = Cysticercosis; AIN = Anemic Infarction; ENT = Enteritis; ABR = Abrasion; OTH = Other. *Values highlighted represents the reject with more impact in organ of pigs slaughtered by Brazilian industry.

Food safety and losses reduction in the pork supply chain is a result of the observance of rules and good practices applied on pig production, logistics and slaughter process. Thus, the control and monitoring of the pork industry by S.I.F is important to ensure the quality of products that companies offer to consumers. Quality management system functions involve quality policy and strategies in order for improvement of process. Therefore, we consider that a development of quality management system to the pork industry can reduce food losses and increase food safety.

4 Conclusion

The higher losses in Brazilian pork industry associated with issues that can occur during pig production, transportation and processing process. Improve the control of process during these three phases could be reducing the quality and health problems, increase the safety, guarantee the food security and increase pork market profits. The Brazilian pork industry had an economic impact estimated in US\$ 27.827 million per year considering the main parts of carcass rejected. The main reasons of condemnation are contamination, urinary cyst, nephritis, pneumonia, congestion and emphysema.

The Information Management System of Federal Service Inspection is an important database to analyze quality issues in the pork supply chains. The main reason of rejection by S.I.F. is due to appearance of disease in parts of carcass inspected during slaughter process that arise because of quality issues in farm production, in the pre-handling logistics and slaughter process.

Therefore, it is essential to develop a quality management system in the farms, pre-handling logistics and slaughter process to help control and reduce food losses in Brazil's pork supply chain.

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