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DOI: 10.1016/j.profoo.2016.05.005

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9th International Conference on Predictive Modelling in Food

Estimation of the risk associated to marketing of swine meat contaminated with *Salmonella* spp., employing the William T. Fine method

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Abstract

Swine meat is a growing market in Colombia, reaching 3.1 million of carcasses sold in 2014. However, it is estimated that the proportion of hogs illegally marketed can be up to 50%, which exposes the population to foodborne pathogens such as Salmonella. The aim of this study was to estimate the risk associated to the marketing of swine meat contaminated with Salmonella, using the William T. Fine method in Tolima Department. The risk scenarios applied to four municipalities positive for Salmonella showed a medium and low level of risk, and an exposed population of 114,000 people, representing 8.7% of the Department's population. In the worst-case scenario, costs for hospitalization and compensation could represent more than US$ 145 billion for the biggest municipality. It can be concluded that the William T. Fine method is applicable for biological risk analysis focused on foodborne pathogen outbreaks.

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1. Introduction

Foodborne diseases (FBD) are a problem that affects both developed and developing countries. Salmonellosis is an infection caused by eating foods, such as pork, beef, poultry and other meat products, which are contaminated with *Salmonella* spp., causing gastroenteritis or typhoid fever in humans.[1,2,3]. In Colombia, in the period between January 2008 and August 2010, 102 FBD outbreaks were recorded, 31.7% being salmonellosis. In 2014, FBD caused by *Salmonella* spp. prevalence was 1,5%[4,5].

To reduce the incidence of FBD on food production chain, the implementation of control systems, like hazard analysis control point (HACCP), is necessary. Currently, different methodologies based in surveys to measure de risk in the food industry exist, but the implementations of these processes are delayed and complex. William T. Fine (1971)[6] published a method to calculate risk and cost of the implementation of a remedial action to correct a hazard. This method combine all scenarios of consequence, exposition and probability of a possible hazard event occurrence. Currently, this method is used to estimate the degree of attention that should be paid to different risks, whether physical, chemical or biological, that occur in companies to establish priority ranges to address a risk between high, medium and low[7].

The aim of this project was to estimate the prevalence of *Salmonella* spp. in slaughterhouses and outlets of swine meat. The analysis identified a prevalence of 5% in the six municipalities evaluated and sampled. Tolima Department have 47 municipalities and only eight slaughterhouses of swine meat. Nevertheless, only one met all requirement for pork slaughtering. Remaining seven need adjustments and the other municipalities have no interest in implementing pork slaughterhouses. Due to the circumstances exposed before, the risk associated to the marketing of swine meat contaminated with Salmonella was estimated using the William T. Fine method, assessing the costs for the medical attention if hypothetically a salmonellosis outbreak occurred.

2. Materials and methods

A survey of Good Practice of Manufacture (GPM) was done in six slaughterhouses and 73 outlets of swine meat, in 2010 in six municipalities of Tolima. Only four of the municipalities were salmonella positive. Estimation of risk with Fine method was performed on those four municipalities, by selecting the parameters (Table 1) and replacing them in the equation 1.

$$R = C \times E \times P \tag{1}$$

Where, **R** represents the risk; **C** are the consequences of the risk; **E** is the exposure to the risk; **P** is the probability that the risk occurs leading to the occurrence of an unwanted event.

Table 1. Descriptions and rating for the principal consequences, probability and risk exposure selected in this study[6].

Rating	Consequences
10	Fatality: damages US$ 5,000 to US$ 10,000
6	Extremely serious or disabling injuries: damages US$ 1,000 to US$ 5,000
4	Injuries with temporary inability: damages US$ 500 to US$ 1,000
1	Minor cuts, bruises, bumps: damage up to US$ 500
Rating	**Probability**
7	Is quite possible. Would not be unusual. 50% of probability.
Rating	**Exposure**
6	Frequently (approximately once daily)
2	Occasionally (from once per week to once per month)

The **DR** (degree of risk) was calculated as the product of **R** and **HF** (Hazard factor). The HF (Table 2) was estimated as the percent of people exposed to swine meat contaminated with Salmonella (in concordance with the results of meat samples) in relation to the swine meat intake calculated in Colombia[8].

Table 2. Estimation of population exposure to risk for intake of swine meat with *Salmonella*

Municipality	Rating	Hazard Factor	Population exposure (approximation)
Ibagué	1	1 - 20%	93172
Líbano	1	1 - 20%	5154
Fresno	2	21 - 40%	5707
Guamo	4	61 - 80%	12930

3. Results and discussion

The estimation of risk by the William T. Fine method is used to calculate the degree of attention that should be paid to the different risks and it is implemented by security companies and banks[6,7,9]. According to the data obtained in this study, the risk of contamination with *Salmonella* spp., in the four municipalities, is low and medium (Table 3). With an exposure to risk of 3% weekly, approximately.

Table 3. Results of William T. Fine estimation of risk for two scenarios and total cost for hypothetical outbreak

Municipality	R (C x E x P)	HF (Rating of Hazard Factor)	DR (R x HF)	Cost for scenario (USD)	Total cost for outbreak (millions of USD)
Ibagué	14	1	14	500	$ 241.67
	420	1	420	10000	$ 145,000.00
Líbano	14	1	14	500	$ 25.00
	420	1	420	10000	$ 15,000.00
Fresno	14	2	28	500	$ 58.33
	420	2	840	10000	$ 35,000.00
Guamo	14	4	56	500	$ 300.00
	420	4	1680	10000	$ 180,000.00

Unlike the HACCP system, the Fine method contemplates different risk scenarios, depending on the combination of consequences, exposure and probability, and estimates the cost that this would entail if those scenarios were presented. In USA, it is estimated that US$ 3,000 million are spent, plus losses in productivity due to disability, for the treatment of salmonellosis. In Colombia, the San Ignacio Hospital reported that a patient with salmonellosis would entail a cost for hospitalization of US $500 daily and a patient with salmonellosis complicated by immunosuppression hospitalized in intensive care can generate a daily cost of up to US $ 1,200[4]. The hypothetical scenarios contemplated in this estimation reveal the importance of investing in the adequacy of facilities and training of food handlers, which would optimize the use of resources by government agencies.

4. Conclusion

The method of William T. Fine is applicable for biological risk analysis focused on the costs that are generated when an outbreak caused by food illness like Salmonella occurs. This method can be applied together with other systems of GPM in the food industry to establish management planes.

Acknowledgements

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