

Microbiological Risk Assessment and Its Use in Food Industry

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Abstract: Risk assessment is a novel approach, which is the estimation of the impact of hazards and the identification of components. The process in risk assessment is hazard identification, hazard characterisation, exposure assessment and risk characterisation. As a means of hazard evaluation, microbiological risk assessment links food and risk factors, such as food-borne bacteria, through data to predict their hazards relatively accurately and reliably, thereby reducing their impact on public health. This study mainly introduces the scientific information about risk assessment and the quantitative microbiological risk assessment in the instant food, mainly to evaluate the level of *Listeria* in foods. Meat products cause 60% of *Listeria* monocytogenes.

Keywords: Microbial risk assessment; *Listeria*; Ready-to-eat (RTE) foods.

1. Introduction

Risk assessment is one of the links in risk analysis, and other links are risk management and risk communication. It is widely applied in food safety, for example, making food safety decisions to reduce the risk hazard for the specific foods. Simply, the risk assessment can be recognized as a systematic tool for determining and describing hazard factors and their relationship to food safety. In the food industry, these hazards are seen as factors (including biological, chemical or physical aspects) that affect food quality or safety, such as foodborne pathogens. In fact, this analytical approach is beginning to contribute to microbiological food safety risks.

Microbiological risk assessment (MRA) is a method of assessing microbial public health risks associated with food, direct contact or the environment. The result of a microbiological risk assessment is the evaluation of the probability of pathogens in a particular population. Besides, in the context of food processing, problems related to food quality or food security can be found by MRA. Therefore, in general, the microbiological risk assessment is becoming an essential approach of managing and ensuring food safety; and the application of MRA for evaluation and management of microbial human health risks is a relatively recent development.

The purpose of this article is to introduce the scientific information about microbiological risk assessment and discuss the example of microbiological risk assessment in the development of ready-to-eat (RTE) foods.

2. Components of MRA

Microbiological risk assessment has been subdivided into four steps, which comprise, hazard identification, hazard characterization, exposure assessment and risk characterization (Membré, & Boué, 2018). The structure of MRA is shown in Figure 1.

The process of MRA is conducted by clearing a goal statement, initially. It explains both the objectives and range of the risk assessment. Some restrictions, the output, and risk characterization also need to be mentioned. For instance, the

probability of infection is cases per 100,000 (ICMSF, 1998).

Hazard identification is the second process. It identifies microorganisms or toxins of interest, and to evaluate the presence or absence of bacteria or viruses' harmful risks in food. The focus of hazard identification varies according to the end use of the risk assessment. In any case, however, the usage of high-quality public health data and information about the occurrence and level of pathogenic microorganisms in food is the pivotal to successful identification of hazards.

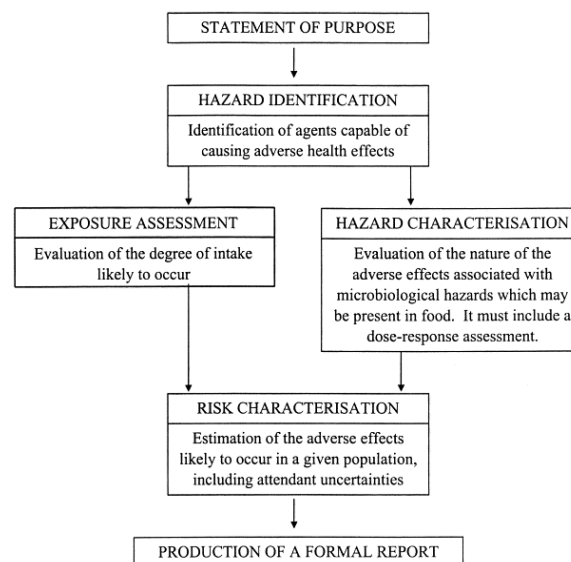


Figure 1. Main procedures in the development of MRA

The next step is an exposure assessment, which is designed to assess the amount of microbial or microbial toxins in the diet. A reliable exposure assessment involves three different forms of cognition: (i) the existence or absence of pathogens in the original components; (ii) the influences of food preparation, processing and transportation on pathogenic bacteria; as well as (iii) consumption structure (Voysey & Brown, 2000).

It is well known that the presence of a specific pathogen is often sporadic and is usually not well distributed in food. Information about the extent and frequency of contamination

is considered, including factors that affect these points, like regional and/or seasonal changes.

This is followed by a hazard characteristic that assesses the nature of the harmful effect associated with hazardous substances in the food, including estimates of the extent and timing of the hazard. Finally, the risk characteristics. It provides an overall probability of occurrence and severe health effects in a given population.

3. Examples of microbial risk assessment

Microbiological risk assessment has a wide range of applications in the food processing industry to assess foodborne pathogenic bacteria present in food. Common pathogens are *Listeria*, *Salmonella*, *Escherichia coli* and *Campylobacter jejuni*.

Nowadays, a risk assessment of RTE foods is a development trend. RTE food is a broad and diverse food that can be subdivided into a number of different ways and varies by country and region (FAO/WHO, 2004). In previous studies, a quantitative microbiological risk assessment was used to investigate the effects of food processing operations on bacterial levels, for instance, Gougouli Kalantzi, Beletsiotis, & Koutsoumanis (2011) to study the growth levels of different fungal hyphae in yogurt under temperature changes. Panagou, Skandamis, and Nychas (2003) examined the extent to which fungi grow on canned olives.

Foodborne listeriosis is a serious and rare disease with a mortality rate of 20-30%, which compared with other pathogens (Rocourt, BenEmbarek, Toyofuku, & Schlundt, 2003; Gombas, Chen, Clavero, & Scott, 2003). The illness is mainly related to the monocytic gene of *Listeria*. A lot of investigations have shown that *Listeria monocytogenes* is present to some extent in a variety of ready-to-eat (RTE) foods.

As RTE foods are an abundant food category, it was impossible to consider all RTE foods. This article selects RTE meat products to illustrate the process of changing the risk level of listeriosis under conditions of an interaction of different factors. The FDA noted that deli meats contribute the most to *Listeria monocytogenes* in 23 "ready-to-eat" foods (Mataragas, Zwietering, Skandamis, & Drosinos, 2010). As well as, 60% of *Listeria monocytogenes* disease is caused by the consumption of RTE meat products (Mataragas et al., 2010).

Additionally, Mataragas, Skandamis, and Drosinos (2008) found that the *Listeria monocytogenes*/RTE meat product portfolio poses a high risk to specific populations, especially the elderly. Similarly, Ross et al. (2009) also found that Australians aged 65 or older were susceptible to listeriosis with 10.16% and 13.7%, respectively (see Table 1 for details), and this ratio is in Sweden that is estimated to be 20.1% (age higher than 65 years old) (Lindqvist & Westöö, 2000). In addition to age factors, some diseases such as cancer (1.42%) or diabetes (1.97%) are also conditions that induce infection with listeriosis. Pregnant women are also one of the vulnerable people.

Based on this conclusion, Mataragas and his colleagues (2010) conducted further research, mainly for high-risk groups. Advanced sensitivity analysis (Figure 2) and a sensitivity map (Figure 3) are used. Factors such as home refrigerator temperature and retail temperature, retail population, consumption, household storage time, and retail

were identified as important factors influencing the number of cases of listeriosis.

Table 1. Proportion of Australian populations at risk of foodborne illness (Sumner, Ross, Jenson, & Pointon, 2005)

Predisposing condition	Proportion of Australian population affected (%)
Age >65 years	10.16
Age >60 years	13.70
Age <30 days	0.11
Organ transplant recipients – kidney	0.03
Organ transplant recipients – other	0.01
HIV	0.10
AIDS	0.01
Cancers (non-melanoma)	1.42
Pregnancy	0.99
Kidney disease or dialysis	0.03
Cirrhosis, chronic liver disease	0.12
Diabetes (reported, Type 1 only)	1.97
Hepatitis (all forms)	0.03
Alcohol dependency	0.10
Total (including age >65 years)	15.2
Total (including age >60 years)	18.7

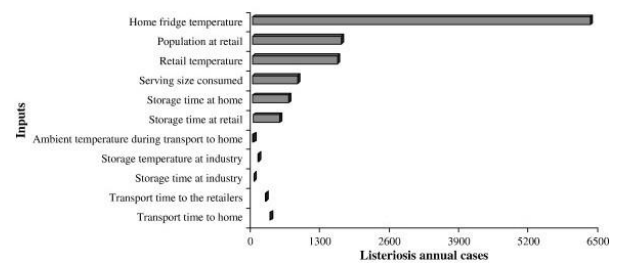


Figure 2. The output of crude and advanced sensitivity analysis

Retail and home storage conditions (temperature and storage time) are critical parameters that influence the final risk assessment. As shown in Figure 3 below (d and f), the number of RTE products contaminated with *Listeria* increased dramatically when the temperature was above 7-9 degrees Celsius. Therefore, it is necessary to store the product at a temperature below this level because it inhibits the growth of pathogens. In addition, when the ready-to-eat meat products are consumed for more than 5 days (family) or 22 days (retail), the number of a pathogen within the product s increased (b and e).

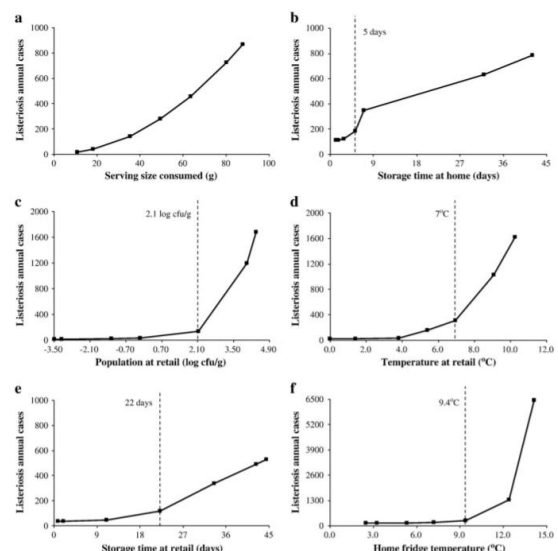


Figure 3. Changes of *Listeria* contamination levels under different parameters

More critically, compared to retail, goods are more likely to endanger human public health under household storage

conditions. Therefore, it is recommended that people buy and refrigerate RTE food and consume it as soon as possible.

4. Conclusion

Risk assessment is ground on the identification and characterization of hazards. In the same way, it cannot predict newly emerging microbial threats to human health associated with foods. Microbiological risk assessment is a unique scientific method that links food data (from farm to table) to various data on human diseases to estimate the impact of contaminated food on human public health. It is also the most effective tool today to assess the efficacy of every possible mitigation strategy. However, it also has certain flaws. Risk assessment is based on the identification and characterization of hazards. Therefore, it cannot predict the threat to human health from emerging food-related microbes.

In general, risk assessment is an important method. Food safety managers can obtain information about the presence and growth of pathogenic microorganisms in foods to draw conclusions and make the necessary decisions to ensure food safety. More importantly, the proposed approach and use of the plan encourages mutual cooperation between countries and provides a transparent system for comparing foodborne risks and mitigation potential.

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