EVALUATION OF MICROBIOLOGICAL PERFORMANCE OBJECTIVES FOR THE BEEF INDUSTRY

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Introduction

Considerable advances in the development of quantitative risk assessment modelling of microbial pathogens in food have occurred in the past ten years. Simultaneously, risk-based management approaches to food safety have been introduced. These involve the application of food safety objectives (FSO), performance objectives (PO), and performance criteria (PC) in order to relate public health goals to the level of stringency required for food safety measures and systems.

FSO for microbiological criteria can be defined as the maximum prevalence and/or numbers of a microbial hazard in a food considered tolerable for consumer protection at the time of consumption. Setting the FSO at the time of consumption requires setting of Performance Objectives (PO) and Performance Criteria (PC) at critical points further back in the food chain. A PO is the maximum level (frequency and/or concentration) of a hazard in a food at a specified point in the food chain that should not be exceeded in order to achieve an FSO. A PC is the outcome of one or more steps in the food safety management system that must be met in order to achieve an FSO. From these parameters, food safety controls such as process criteria, product criteria and microbiological criteria may be derived. This paper presents an example of deriving risk-based criteria for *Escherichia coli* O157:H7 using risk assessment information. Food, especially undercooked beef burgers, has been implicated in many outbreaks of *E. coli* O157:H7 worldwide. For the present work, a previously developed risk assessment model for *E. coli* O157:H7 in Irish minced beef (Duffy, 2006) was used to generate a series of performance objectives and food safety objectives and demonstrate how these values influence the baseline risk per serving.

Materials and Methods

In this case study, potential performance objectives were selected based on the results of surveys of *E. coli* O157:H7 prevalence and numbers on beef trimmings and beef burgers in Ireland (Cagney 2004; Carney, 2006). A wide range of different combinations of prevalence and concentration values at the point of boxed trim or for freshly formed 100g beef burgers were selected as potential PO (Table 1).

Table 1: Potential performance objectives to be evaluated using the Duffy *et al.* (2006) risk model.

PO	Location	Initial prevalence (%)	Initial numbers (CFU/g)
1	Trimming	0.25	1
2	Trimming	0.5	1
3	Trimming	0.5	100
4	Trimming	2	1
5	Trimming	2	100
6	Trimming	3	100
7	Trimming	0.25	0.01
8	Trimming	0.1	1
9	Trimming	0.1	0.01
10	Trimming	0.05	1
11	Trimming	0.05	0.01
12	Trimming	0.25	0.001
13	Burger	0.25	1
14	Burger	0.5	1
15	Burger	1	100
16	Burger	2	100
17	Burger	3	1,000
18	Burger	3	10,000
19	Burger	0.1	1
20	Burger	0.01	1

These values were substituted into the Duffy *et al.* (2006) risk model for a fresh refrigerated beef burger and keeping all other post-production assumptions (for storage, handling, preparation, etc.) the same as in the original assessment, the model was re-simulated to generate outcomes for concentration (dose) and prevalence at time of consumption (after cooking), and the expected risk of illness.

Results and Discussion

Duffy *et al.* (2006) predict that the mean risk of *E. coli* O157:H7 illness from the consumption of a 100 g portion of a fresh, refrigerated beef burger in Ireland was approximately 1 in 1 million (exact value -5.94 log).

The results of re-simulating the Duffy *et al.* (2006) risk model with the relevant PO are presented in Table 2. These results show that the risk of illness is dependent on both the prevalence and numbers of *E. coli* O157:H7 on beef trimmings and in beef burgers. For example, in the case of a prevalence of *E. coli* O157:H7 on beef trimmings of 0.25% (potential PO 1 and 7) but with different counts (1 and 0.01 CFU/g), the resulting (mean) estimates for the probability of illness (in log units) per serving are -3.77 and -7.35 respectively. Similarly, for the same average *E. coli* O157:H7 count on trimmings, for example, 0.01 CFU/g, (potential PO 9 and 11) but with different prevalence values (0.1%, and 0.05%), the resulting estimate for the mean probability of illness (in log units) are -7.29 and -8.33 respectively.

Table 2: Results of re-simulating the Duffy *et al.* (2006) risk model with the potential PO.

Potential PO	Log probability of illness		
	5th percentile	Mean	95th percentile
1	-3.77	-6.38	-2.28
2	-3.68	-6.21	-1.96
3	-3.90	-6.18	-1.89
4	-3.71	-5.42	-1.49
5	-3.20	-5.59	-1.29
6	-3.07	-5.44	-1.10
7	-7.35	-7.80	-6.99
8	-4.33	-6.77	-2.61
9	-7.29	-7.42	-7.06
10	-5.71	-7.34	-4.29
11	-8.33	-9.12	-7.89
12	-7.69	-7.82	-7.58
13	-6.30	-8.54	-4.26
14	-6.13	-8.22	-4.01
15	-5.63	-7.99	-3.62
16	-5.34	-7.67	-3.32
17	-5.34	-7.56	-3.11
18	-5.84	-7.56	-3.10
19	-6.77	-8.93	-4.68
20	-7.21	-8.99	-5.06

Conclusions

If a mean probability of illness per serving of one in one million is considered to be a tolerable risk, then potential PO 13, 14, 19 and 20 would be suitable choices as a PO for freshly formed beef burgers, while potential PO 7, 9, 11 and 12 would be suitable choices as a PO for beef trimmings. It would appear that the PO could be "not more than 0.01 CFU/g for beef trimmings" or "not more than 1 CFU/g for beef burgers". The PO need not be more stringent; likewise, a less stringent PO would not provide a tolerable level of protection. Consideration also must be given to other sources of *E. coli* O157:H7 that result in disease plus whether the goal is to reduce over time or eliminate the number of cases from ground beef. The methodology illustrated in this paper demonstrates how risk assessment models can be used in the setting of PO for improved human health.

References

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