Quantitative risk assessment of *Salmonella* spp. for the whole yellow broiler supply chain in China

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Abstract

- The pathway of the supply chain was modeled as a series of modules including the initial contamination at farm, bacterial growth/inactivation and cross-contamination at slaughter house, bacterial growth/inactivation during storage and transportation, thermal inactivation during cooking, and dose response after consumption. Investigation data, as well as predictive models for *Salmonella* were used to establish model inputs. The quantitative risk microbiological risk assessment (QMRA) was constructed in an Excel spreadsheet and simulated using @Risk 6.3.
- The average and maximum number of Salmonellosis cases per 10,000,000 consumer is 1 and 29, respectively. Sensitivity analysis identified that temperature in the transportation from market to household, the concentration of sodium hypochlorite, initial contamination concentration, and cross-contamination in wholesale market were the most significant input parameters.

Introduction

- Food-borne illness due to *Salmonella* is a major public health problem, and poultry products are the most common outbreaks sources throughout the world.
- Yellow broiler is one of the most popular chicken species among consumers in China.
- A few risk assessment models have been developed, while most of them focus on the stage of retail to consumption, not the whole supply chain.

Objectives

- The aim of this study was to develop a QMRA model of *Salmonella* for the whole yellow broiler supply chain.
- To estimate the infection risk for consumers, and determine the critical control points (CCPs) for preventing the *Salmonella* contamination in poultry supply chain.

Materials and Methods

◆ Bacteria strains

Five serovars of *Salmonella* (Stanley BYC12, Indiana HZC10, Typhimurium YXC1, Thompson LWC10, Kentucky CBC2) isolated from a poultry slaughter house were obtained from the Liao laboratory at the South China Agricultural University, Guangzhou, China.

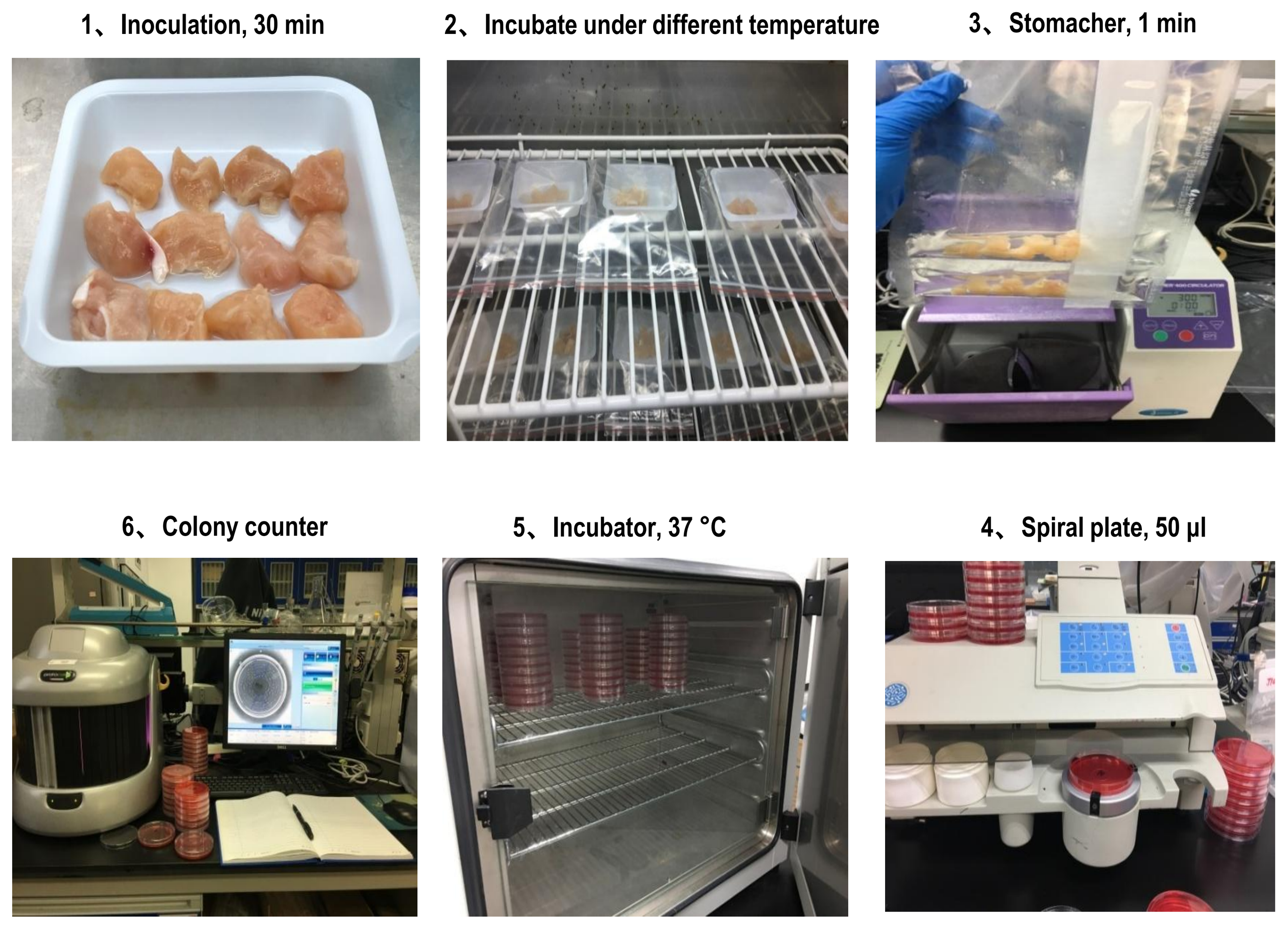

Fig. 1 The scheme of enumeration of *Salmonella* in chicken samples

◆ Collect model input parameters

- Temperatures at each module
- Processing time at each module
- Chlorine concentration in chilling water
- Initial prevalence and contamination level

◆ Develop predictive models/distributions

- Bacterial growth/survival under different temperatures
- Cross-contamination

◆ QMRA

$$P(ill) = prob \times cont \times (dose: \ response)$$

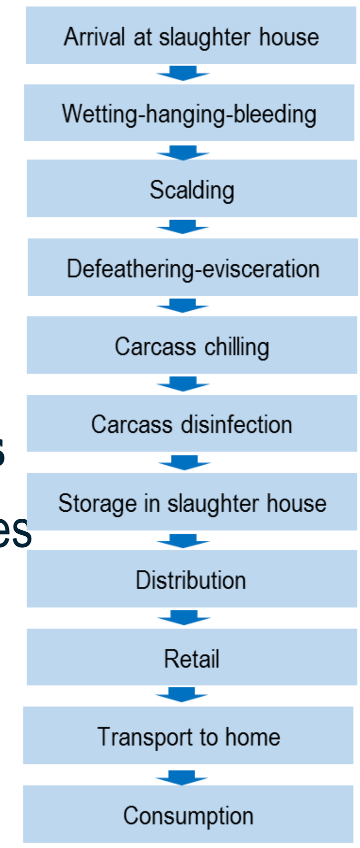

Fig. 2 Risk modules

Results and Discussion

● Bacterial growth/survival under different temperatures

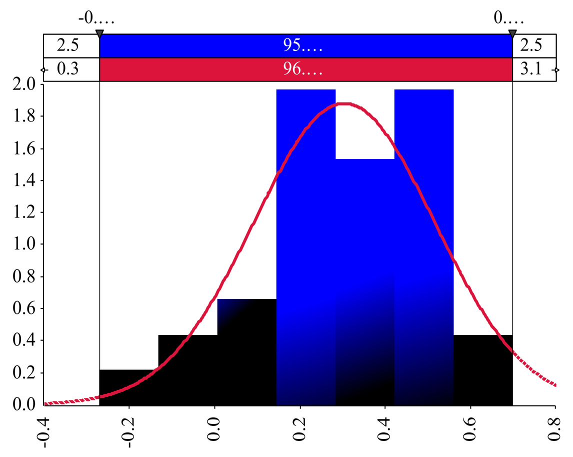

Fig. 3 Refrigeration storage (2 – 8 °C)

A Normal (0.30,0.21) distribution could describe bacterial survival at refrigeration storage (Fig. 3).

● Primary model: Modified Gompertz model

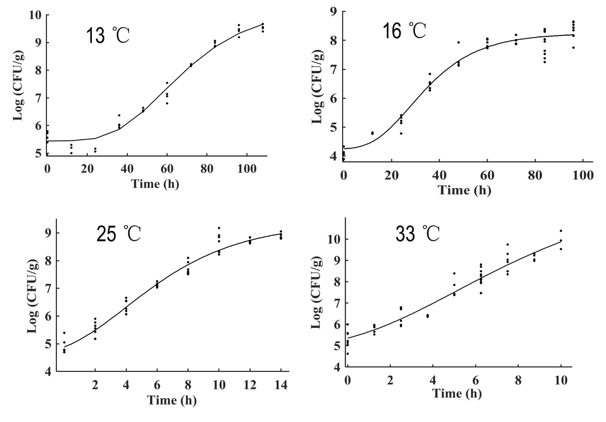

Fig. 4 Room temperature storage (10 –38 °C)

● Secondary model: Arrhenius Model

$$\mu_{max} = 0.002*(T+273.15)*exp-[(2424.9)/(8.134(T+273.15))]^{(49.767)}$$

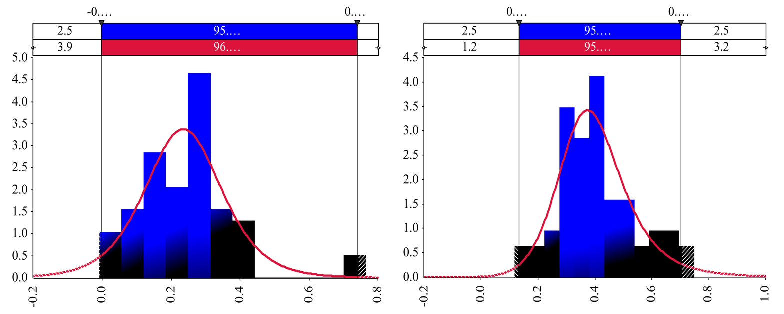

Fig. 5 Scalding at 50 and 60 °C

A Logistic (0.23,0.074) and LogLogistic (-0.25,0.64,8.67) distribution could describe bacterial survival at 50 and 60 °C, respectively (Fig. 5).

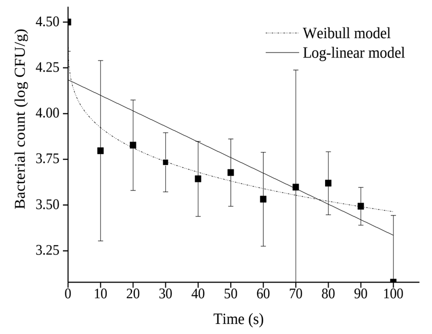

Fig. 6 Scalding at 70 °C

Weibull model showed a satisfied fitness at 70 °C (Fig. 6).

● Cross-contamination

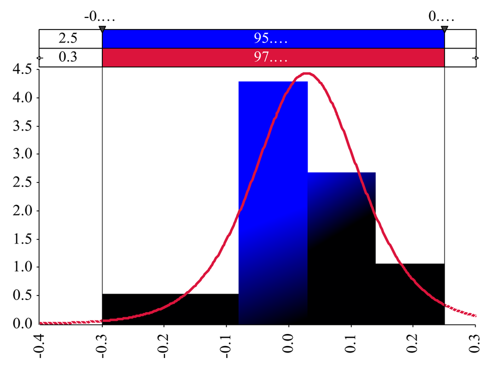

Fig. 7 Cross-contamination in evisceration

A Logistic (0.028, 0.056) distribution could describe bacterial prevalence after Cross-contamination in evisceration (Fig. 7).

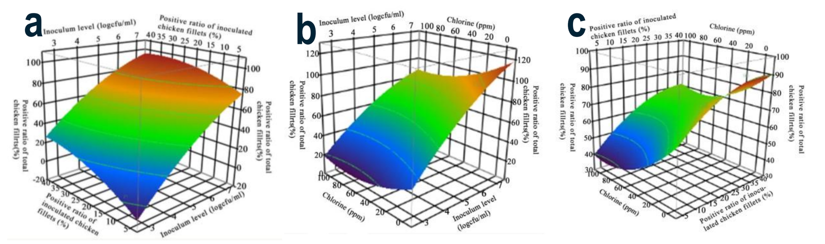

Fig. 8 Response surface plots describing the effect of inoculum level and pre-chill prevalence (a); inoculum level and chlorine concentration (b); and pre-chill prevalence and chlorine concentration (c) on post-chill prevalence of *Salmonella* in chicken.

An optimum treatment combination (inoculum level at 3 log cfu/ml, pre-chill prevalence at 3%, and 50 ppm chlorine concentration) that could achieve the lowest post-chill prevalence of 21.5% (Fig. 8).

● QMRA

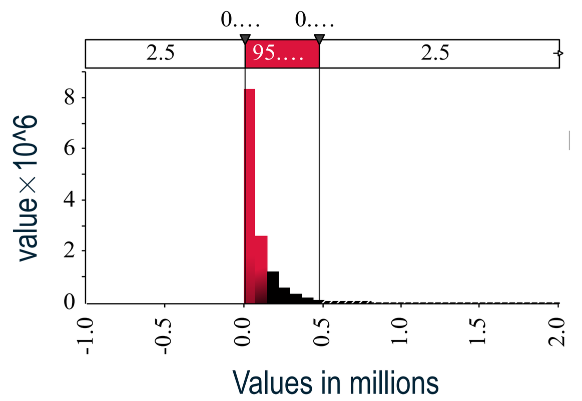

Fig. 9 Risk simulation results of yellow broiler in supply chain

Minimum	0.00000
Average	1.01E-007
Maximum	2.94E-006
Standard deviation	1.56E-007

The average and maximum number of *Salmonellosis* cases per 10,000,000 consumer is 1 and 29, respectively .

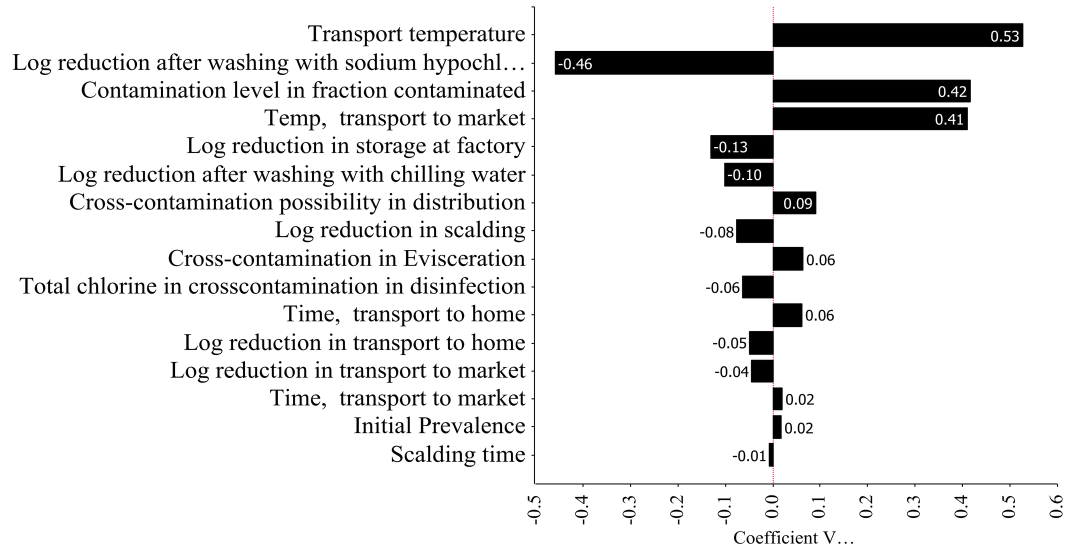

Fig. 10 Sensitive analysis of risk in consumption

Conclusions

✓ The average and maximum number of *Salmonellosis* cases per 10,000,000 consumer is 1 and 29, respectively.

✓ Sensitivity analysis identified that temperature in the transportation from market to household, the concentration of sodium hypochlorite, initial contamination concentration, and cross-contamination in wholesale market were the most significant input parameters.

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