Title	Prediction of pathogen growth on iceberg lettuce under real temperature history during distribution from farm to table
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Abstract

The growth of pathogenic bacteria *Escherichia coli* O157:H7, *Salmonella* spp., and *Listeria monocytogenes* on iceberg lettuce under constant and fluctuating temperatures was modelled in order to estimate the microbial safety of this vegetable during distribution from the farm to the table. Firstly, we examined pathogen growth on lettuce at constant temperatures, ranging from 5 to 25 °C, and then we obtained the growth kinetic parameters (lag time, maximum growth rate (μ_{max}), and maximum population density (MPD)) using the Baranyi primary growth model. The parameters were similar to those predicted by the pathogen modelling program (PMP), with the exception of MPD. The MPD of each pathogen on lettuce was 2–4 $\log_{10}$ CFU/g lower than that predicted by PMP. Furthermore, the MPD of pathogens decreased with decreasing temperature. The relationship between $\sqrt{\mu_{max}}$ and temperature was linear in accordance with Ratkowsky secondary model as was the relationship between the MPD and temperature. Predictions of pathogen growth under fluctuating temperature used the Baranyi primary microbial growth model along with the Ratkowsky secondary model and MPD equation. The fluctuating temperature profile used in this study was the real temperature history measured during distribution from the field at harvesting to the retail store. Overall predictions for each pathogen agreed well with observed viable counts in most cases. The bias and root mean square error (RMSE) of the prediction were small. The prediction in which μ_{max} was based on PMP showed a trend of overestimation relative to prediction based on lettuce. However, the prediction concerning *E. coli* O157:H7 and *Salmonella* spp. on lettuce greatly overestimated growth in the case of a temperature history starting relatively high, such as 25 °C for 5 h. In contrast, the overall prediction of *L. monocytogenes* under the same circumstances agreed with the observed data.