

Quantitative exposure assessment of *Listeria monocytogenes* in salad vegetables

¹Lay Ching Chai, ¹Jeyaletchumy Ponniah, ¹Farinazleen Mohd Ghazali, ³Yoshitsugu Nakaguchi, ³Mitsuaki Nishibuchi, ¹Son Radu

¹Centre of Excellence for Food Safety Research, Faculty of Food Science and Technology, University Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

²Center for Southeast Asian Studies, Kyoto University, Kyoto, Japan

The objective of the present work was to develop a quantitative exposure assessment model in which the risks of acquiring listeriosis from consumption of cabbage, lettuce and tomato as salads were estimated. Sampling and studies were conducted in the laboratory to obtain data and information on prevalence, concentration and log reduction of vegetable washing. An excel spreadsheet model was constructed in which variables were represented by probability distributions based on data and information collected. Three scenarios were explored through the model to estimate the exposure and risks of acquiring listeriosis. The model was run through Monte Carlo simulations using the @Risk 5.5 software (Palisade Corporation). A flexible Weibull-Gamma dose-response model was used to estimate probability of illness in high-risk and low-risk groups of consumer. In this study, retailed cabbage (21.9%), lettuce (12.5%) and tomato (21.9%) were found to be contaminated with 1.38 ± 0.80 , 0.85 ± 0.26 , and 0.77 ± 0.24 log MPN/g of *L. monocytogenes*, respectively. The estimated mean risk per serving was 8.15×10^{-6} (cabbage, high-risk group), 4.74×10^{-10} (cabbage, low-risk group); 6.16×10^{-10} (lettuce, high-risk group), 3.23×10^{-14} (lettuce, low-risk group); and 6.35×10^{-10} (tomato, high-risk group), 3.33×10^{-14} (tomato, low-risk group), respectively. The second scenario described consumption of raw cabbage, lettuce and tomato after washing with tap water. The finding revealed significant correlation between initial microbial load (log MPN/g) and log reduction of washing. The relationship could be described with equation: $\log \text{reduction} = -0.4227 (\log \text{initial microbial load}) + 0.9258$. Consumption of cabbage, lettuce and tomato after washing generally decreased the risk of acquiring listeriosis. However, the decreasing rate in cabbage was not significant due to higher initial microbial load in cabbage. In third scenario, probabilities of illness were estimated for a decrease in proportion of virulent strains (from 100% to 0- 10%; uniform distribution). The risks of acquiring listeriosis for high-risk and low-risk groups from consumption of washed or unwashed vegetables were ranged $4.45 \times 10^{-12} - 1.00 \times 10^{-11}$ and $1.72 \times 10^{-16} - 5.06 \times 10^{-16}$, respectively. The exposure assessment model was most sensitive to the input distribution describing the serving size and to a lesser degree on the initial concentration of *L. monocytogenes* in the vegetables and the proportion of virulent strains. This study clearly indicates consumption of contaminated salad vegetables as a highly potential source of *Listeria monocytogenes* infection in human. However, the study has also identified various data gaps, uncertainties and variability in which more surveys and studies are needed in order to conduct a full quantitative microbial risk assessment.