Can stochastic consumer phase models in QMRA be simplified to a single factor?

In quantitative microbiological risk assessment (QMRA), the consumer phase covers the part of the food chain following production and retail, where the consumer transports, stores, prepares and consumes the food products considered. These consumer practices have a crucial impact on exposure, and a consumer phase model (CPM) needs to be included in a QMRA to allow an evaluation of the effectiveness of intervention measures in food production and processing in terms of human health risk. However, the development of a CPM is complex because consumer practices can be highly variable and data are scarce. So far, it is unclear to which extent CPMs need to include data on variability and detailed descriptions of the stochastic processes that may result in exposure. We therefore compared the performance of published stochastic CPMs with a simple surrogate CPM that assumes a proportional linear relation between concentration at retail and ingested dose, described by a constant factor. A comparative study was performed for different pathogens and different food products: Campylobacter in broiler meat, Salmonella in minced pork and pork cuts and Listeria in smoked salmon. Published stochastic CPMs were re-implemented and their equivalent surrogate models were derived, basing the value of the constant surrogate model factor on the absolute risk estimate from the stochastic model. The performances of the models were evaluated by comparing the effects of hypothetical intervention measures that reduce the mean or the standard deviation of the distribution of concentrations at retail. These effects were expressed in terms of relative risk estimates, as estimated in the risk assessments using the simplified and the stochastic CPMs. Results showed that after interventions that result in a reduction of the mean or standard deviation of the distribution of concentrations at retail, the relative risk estimates obtained for the simple surrogate models are always lower than those of the stochastic CPMs, which means that simplified models tend to overestimate the effects of interventions. The difference was largest in the Listeria model, where growth during storage is expected to be the dominant process. It was found that for interventions affecting the prevalence only, a simplified surrogate CPM performs similarly to a stochastic CPM. We concluded that the use of a simple surrogate CPM, which does not include the variability inherent to consumer practices, may lead to an overestimation of the effect of intervention measures in a QMRA, especially in these interventions affect the concentrations. For adequate risk assessment, it may therefore be necessary to include the variation in consumer practices (e.g. variation in storage time and temperature, cooking time and temperature and cross-contamination), as described in more realistic and more complex CPMs, definitely if this variation is expected to be large.

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