USING QUANTITATIVE PREDICTIVE MICROBIAL MODELLING WITH HACCP

Dennis L. Seman*

Department of Animal Science, University of Wisconsin, Madison, WI.

*Corresponding author email: dseman@wisc.edu

Abstract – Microbial modeling has been an evolving science for the past 30 to 40 years beginning first as a method of predicting microbial growth curves under varying cardinal conditions (primary models) to the creation of specific models including other factors and interventions to inhibit microbial growth (secondary models). These have proven to be quite valuable to the food industry in general and the meat industry in particular. Regulatory agencies and various research institutes have use microbial modeling in quantitative microbial risk assessments to rank risks and to test various methods to reduce the risks associated with foodborne illnesses. Today, however, with more computing power available, it is possible to introduce 'next generation' models that include features of microbial and risk modeling to form new, more powerful stochastic models into the day-to-day operations of food manufacturing facilities. Such models can provide a 'truer' representation of the actual processes employed.

Key Words – microbial modeling, microbial risk assessment, stochastic modeling,

I. INTRODUCTION

Microbial modeling is a relatively young field of work. Over the past 30 years or so, it has matured into a science based upon sound principles of biology and mathematics and has been found to be a reliable method of predicting the growth of microorganisms under specific environmental conditions. Other models have also been used in microbial risk assessments in various foods concerning specific food borne pathogens. Microbial models have a place in the production of ready-to-eat (RTE) meat products in a commercial setting by reducing the number of challenge-pack studies required so that a finished product of high quality can be made with the assurance of food safety at a minimum cost. Such models are not only capable of identifying the hazards in a process, but can also show the impact of any process deviation that might occur. Thus the manufacturer will be able to evaluate the next steps required should a deviation ever occur. Using risk ranking and risk matrix techniques will illustrate what aspects of a given process are potentially risker than other parts, but these techniques are not capable of determining the consequence of a process deviation.

The meat industry has many microbial modeling tools available to it at the present time to assist in formulating products according to FSIS post cook lethality guidelines (FSIS, 1999). There is the Listeria Control Model (for use with their products) (Corbion, 2012), COMBASE predictor (Combase, 2017), FSSP (food spoilage and safety predictor) (FSSP, 2014), Danish Meat Institute (DMRI, 2017), and many others including bespoke in-house models created by companies for their own use. These are used in various ways by the users. That is to say that there are no universal "best practices" guidelines for the implementation of these models by meat manufacturers. Each user knowingly or unknowingly writes his own "run rules" when trying to apply the chosen model to their own situation. Consequently, their *true* risk of having a failure probably varies manufacturer to manufacturer. In addition, their *true* risk is not really known due to small variations in the model parameters. For example, if the model has salt content as a variable, the entire batch of product does not have exactly the same salt content due to how the salt is distributed throughout the mass of product being blended. However, most of this variability seems to be ignored since the outcomes thus far have been good enough. Subsequent FSIS risk evaluations in deli meat have shown that the risk of illness have been reduced significantly when *Listeria* growth inhibitors are included in RTE meat items (FSIS, 2010). They have been so successful that processed RTE meats are now not considered a significant risk. These successes; however, may lead to complacency.

II. MODELING AND HACCP

Food manufacturing companies may need more precision or confidence in the safety of their food products than they do now. Or to say it a different way, the current HACCP plans are very good at finding hazards (biological, chemical, and physical) and indicating ways of controlling the hazards, but they do little in accounting for the variability and the uncertainty of controlling the hazards that are in their processes. It does not take too much imagination to see that in the future, after FSMA is fully implemented, that the next step will to account for process variability and after that, process uncertainty. These all become more important when manufacturers consider making the more "natural" products with long shelf lives

III. STOCHASTIC MODELING

There are several reasons that the food industry may not see the necessity of going to the next step in using predictive modeling to also include estimates of variability and uncertainty combined with HACCP. One main reason is that the output of such stochastic treatments is expressed in the language of probability rather than in the more comprehendible pass/fail terms. The CCP's in current HACCP plans are expressed as either being in compliance or not. A second reason is that the data required to create such models may or may not be available with which to create the necessary calculations. Consequently, data would need to be gathered which may entail additional cost for the company. The third reason is related to how the data is handled and how the calculations are made. Generally, these calculations (especially if stochastic models are desired) can be beyond the capabilities of typical Excel spreadsheet users and may require additional resources to complete and implement

IV. CONCLUSION

The next step to the production of safe food products ought to include the new tools of predictive microbiology. These tools of predictive and stochastic modeling can be used in the day to day operations of the manufacturing plant to manage product development in the formulation of new products, production of the highest quality products, and provide information should a deviation occur in the process.

REFERENCES

1. Combase (2017). Combase. http://www.combase.cc/index.php/en/. Accessed on March 22, 2017.
2. Corbion. (2012). Listeria Control Model—2012. http://www.corbion.com/food/meat-and-poultry/solutions/listeria-control-model-2012. Accessed on March 22, 2017.
3. DMRI (2017). Predictive models for meat, Danish Meat Research Institute, https://www.dti.dk/specialists/predictive-models-for-meat/33801. Accessed on March 22, 2017.
4. FSIS (1999). Appendix B Compliance Guidelines for Cooling Heat-Treated Meat and Poultry Products (Stabilization), https://www.fsis.usda.gov/wps/wcm/connect/a3165415-09ef-4b7f-8123-93bea41a7688/95-033F-Appendix-B.pdf?MOD=AJPERES, Accessed March 22, 2017.
5. FSIS (2010). FSIS comparative risk assessment for *Listeria monocytogenes* in ready-to-eat meat and poultry deli meats. https://www.fsis.usda.gov/shared/PDF/Comparative_RA_Lm_Report_May2010.pdf. Accessed on March 23, 2017
6. FSSP (2014). Food spoilage and safety predictor, Technical University of Denmark, http://fssp.food.dtu.dk/. Accessed on March 22, 2017.