Finding a tradeoff between a microbiological risk and a nutritional benefit in foods using a Quantitative Microbial Risk Assessment approach

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OBJECTIVE(S)

Heat processes applied to foods are based on a tradeoff between microbiological safety or stability, and quality (organoleptic characteristics, nutritional value…) of the processed food. The objective of this work was to propose an approach to optimize of the canning process of green beans in accounting for both non stability due to survival and growth of the thermophilic spore-forming bacteria *Geobacillus stearothermophilus* (the microbiological risk) and the vitamin C concentration (the nutritional benefit), an important nutrient in fruits and vegetables, and often used as a marker of process impact on the nutritional value of foods.

METHOD(S)

A model predicting simultaneously the risk of microbiological non-stability at 55°C (a requirement in the canning industry) of canned green beans due to *G. stearothermophilus*, and vitamin C degradation along green bean canning process and storage was built and validated with independent sets of data, such as % of no stability observed in industry or measurement of vitamin C concentrations (Rigaux, 2013). In particular, a vitamin C degradation time at 85°C and at 80 kJ.mol^{-1} DHA activation energy named F_1 and the microbiological thermal death time at 121°C and at reference value $z_T = 10$°C (F_0) were introduced in the model to allow a simultaneous prediction of vitamin C degradation and bacteria inactivation for any given time and temperature during the sterilization process. Parameters of the model were fixed, variable, uncertain, or both uncertain and variable. Uncertainty and variability on parameters were separately propagated through the model within the two-dimensional Monte-Carlo simulation framework.

RESULTS

A mean risk of non-stability due to *G. stearothermophilus* of 0.5% of green bean cans (corresponding to usual industrial observations) was estimated with a 95% uncertainty interval of [0.1%, 1.2%], as the % of cans containing more than 12 mg vitamin C/100 g (i.e. exceeding the nutrition claim limit) was estimated at 3.2 % in mean with a 95% uncertainty interval of [0.1%, 13.2%]. As the mean initial concentration was 17.0 mg vitamin C/100 g with a 95% variability interval of [4.0, 30.6], the model reports a significant degradation of vitamin C. Moreover the model predicts a relative independence between vitamin C concentration and *G. stearothermophilus* concentrations in canned green beans after sterilization. This offers the possibility of optimizing process parameters influencing one output without affecting the other. Then the model was used to test the consequences of some alternative process scenarios maintaining an acceptable level of microbiological non-stability, while increasing the vitamin C concentration. For instance reducing blanching time, increasing F_0, reducing waiting time before blanching and slightly acidifying the covering brine predicted simultaneously a % of non-stability decreased to 0.1% in mean with a 95% uncertainty interval of [0.0%, 0.7%] and more than

30% cans containing concentrations in vitamin C greater than 12 mg/100 g (33.5% in mean with a 95% uncertainty interval of [7.8%, 52.5%].

CONCLUSIONS AND IMPACT OF THE STUDY

Finding a tradeoff between risk and benefit, between food safety and quality, is a common issue in food industry. The modeling framework proposed in the present work, which considers variability and uncertainty of the modeled phenomena, is increasingly familiar to scientists developing Quantitative Microbial Risk Assessment in food. We showed this framework is also adapted to model the evolution of nutrients in foods: parameters of chemical reactions, initial concentrations in nutrients for instance are also uncertain and/or variable. We could therefore consider that food microbiology predictive and probabilistic approaches are useful tools for the design of safe food processing and improvement of food quality looking at the joint distribution of the two criteria.

REFERENCE

Rigaux, C. 2013. PhDthesis.
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