Mathematical model developed to prevent botulism

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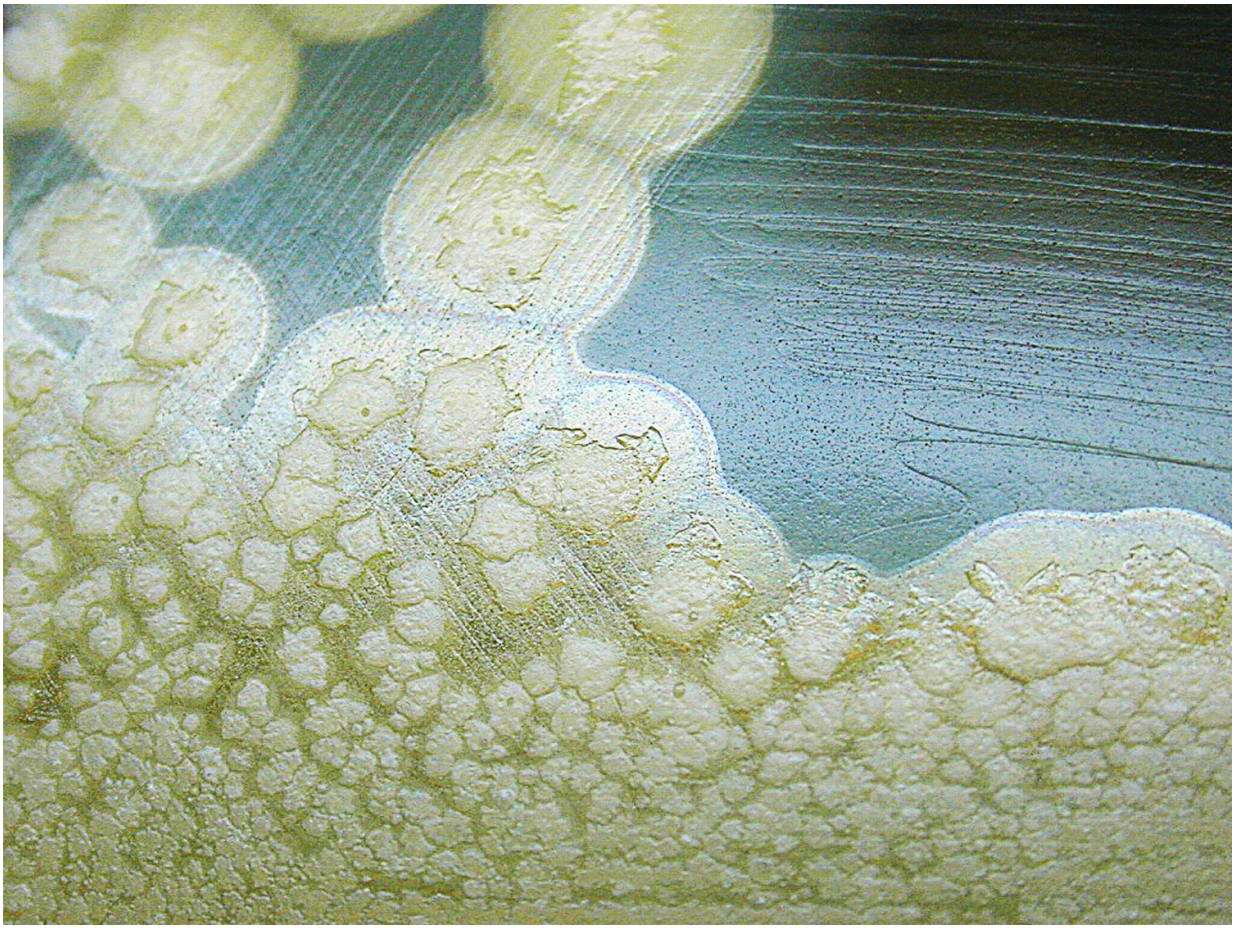

The Clostridium botulinum bacterium (shown here in colonies) can cause foodborne illnesses and potentially deadly effects due to the neurotoxin it produces. Credit: CDC

Food producers can use a mathematical model developed at the National Food Institute, Technical University of Denmark, to ensure their products do not cause botulism. It is the most comprehensive model of its kind.

For years, food producers who make lightly preserved, ready-to-eat food have had to follow a set of guidelines to stop growth of Clostridium botulinum bacteria and production of a strong neurotoxin. The toxin can cause a serious illness called botulism.

For refrigerated products, the guidelines for controlling Clostridium botulinum indicate that the water contained in the products should have a salt content of at least 3.5%. Unfortunately, this hampers efforts to develop salt-reduced products, even though such products would benefit public health, as most consumers eat more salt than recommended.

If food producers want to launch products that contain e.g. less salt, they have had to conduct laboratory experiments to document that such a change in recipe will not compromise food safety. This is a time-consuming and costly process.

Reduced need for costly product testing

Researchers at the National Food Institute have now developed a mathematical model, which replaces costly laboratory experiments. The industry has been asking for this model for years. The new model can predict whether a particular recipe for chilled products can prevent the growth of Clostridium botulinum and production of the toxin.

The model is the most comprehensive of its kind in the world and can show how storage temperature, pH, salt and the use of five different preservatives (such as acetic and lactic acids) affect potential bacterial growth and production of the toxin. Previous models have only

incorporated the effect of half of these factors.

The model was originally developed for use in fish products. However, by conducting validation studies using more than 500 different products, the researchers have established that it can be used to assess the safety of recipes for both fish and poultry.

Future work on the model will include other foods such as meat and vegetable products.

Major interest from the industry

The researchers have described their work with development of the new model in a newly published article in the *International Journal of Food Microbiology*. Because of this, several large food producers have already contacted the National Food Institute with a view to having the safety of their recipes tested using the model.

The next step is to include the new Clostridium botulinum model in the institute's Food Spoilage and Safety Predictor (FSSP) software in order to make it more user-friendly.

The FSSP program already contains a number of models that can predict the growth of disease-causing microorganisms such as Listeria monocytogenes as well as some spoilage bacteria. FSSP is used by food producers all over the world to promote product development and to document food safety and shelf life.

Laboratory experiments using less dangerous bacteria

When conducting experiments using Clostridium botulinum bacteria, strict safety measures must be adhered to in the laboratory, as their

toxins can cause serious illness that can lead to death.

During their work to create the new model, the researchers have used Clostridium botulinum isolates, which cannot form the dangerous toxins but are still useful for predicting the absence of growth and thereby absence of toxin formation in different recipes. The use of these bacteria has made laboratory work considerably less cumbersome.

More information: Ioulia Koukou et al, Cardinal parameter growth and growth boundary model for non-proteolytic Clostridium botulinum – Effect of eight environmental factors, *International Journal of Food Microbiology* (2021). DOI: 10.1016/j.ijfoodmicro.2021.109162

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