Corbion *Listeria* Control Model – Drivers

Shelf-life studies present several challenges.

1. Several food characteristics can impact shelf life results.
   Temperature, Moisture, pH, Salt, Nitrite, Water activity

2. A shelf-life study with undesirable outcomes results in lost time.
   Studies last 90, 120, 150 days... or more! A negative outcome can set a project back and spend useless.

3. Bacterial strains can behave differently.
   Challenging with some *Listeria* strains can result in different results compared to other strains.

4. It’s hard to know where to start or the impact of a change.
   Model can provide input on the impact of various Corbion products to assist in a product launch or a formula change.
The Corbion *Listeria* Control Model addresses these challenges.

1. Several food characteristics analyzed.
   - Temperature
   - Moisture
   - pH
   - Salt
   - Nitrite
   - Water Activity

2. Predictive power saves time.

3. Numerous (>15) *Listeria* strains incorporated from past studies addresses variability.

4. The ability to vary Corbion ingredient levels can provide a starting point.
The CLCM supports customers in product (re)formulation and design of shelf life studies, which reduces R&D costs and speeds up time to market.

Results achieved as long as certain “best practices” are followed, including:

- Model outcomes are used as a *guideline* in designing product formulations and challenge tests.

- Model use *does not replace* challenge studies
  - It should *greatly reduce* the number of challenge studies needed.

- Product parameters are entered as *accurately as possible*
  - When unsure, make a safe estimate
The guiding principle of the CLCM is the gamma concept.

- Gamma concept applied to describe influence of environmental parameters like temperature, pH, water activity and growth inhibitors on the growth rate

\[ \mu = \mu_{opt} \cdot \gamma_T \cdot \gamma_{pH} \cdot \gamma_{aw} \cdot \gamma_{product} \]

- \( \mu_{opt} \) is the growth rate under optimal conditions and \( \mu \) is the actual growth rate given a set of preset environmental parameters.
- \( \gamma \) is the function of the effect of each environmental parameter and has a value between 0 and 1.

### Environmental Parameters
- Temperature
- Lactic acid
- Propionic acid
- Water activity
- Acetic acid
- pH
The CLCM effectively considers variability.

Different sources of variability can affect model performance:

• Strain variability
• Biological variability
• Food matrix composition
• Growth history
• Measuring errors

As a result of this variation, the CLCM provides a probability distribution rather than a fixed outcome:

• Best fit line: 50% of the samples will grow faster and 50% will grow slower than the best fit value.
• 95% line: 5% of the samples will grow faster and 95% will grow slower than 95% value.
Listeria growth most likely to be centered in the grey area

Substantial risk of growth following the 95% line
Detailed results

- .pdf summary
- Contains more detailed information (lag time, growth rate)
- Prediction of shelf life at different dosage levels of current formulation
The CLCM will help you...

- Determine the parameters and scope of future challenge testing
- Assist in exploring formulation changes prior to challenge testing
- Limit errors from strain differences, measuring inaccuracies, and food matrix inconsistencies due to the variance captured by the model
- Shorten the product development cycle – limit the spend on challenge studies
- Speed up time to market

Given that the following are acknowledged:

- Control of *Listeria* requires SSOP and HACCP
- The model serves as a guide but is not a substitute for challenge studies
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Walking through the model:

Select region & food type

Please select the region you are in and the food type you wish to design. The model will adjust all settings and units accordingly.

Region

Food Type

Additional information

Next
Input by customer

Further explanation

Celsius or Fahrenheit

Corbion portfolio can be selected

Availability to calculate TTG1, TTG2, etc.
Water activity

Calculated $a_w$

The model can calculate your $a_w$ and will display the calculated value in the grey box

- No Corbion product is defined: $a_w$ without Corbion product is displayed
- Corbion product added: Aw of total formulation is displayed (the aw of the control situation can be found in the pdf).

Measured $a_w$

When you have measured the $a_w$: untick the box and fill in the measured value of the total formulation

- The model will back calculate a new control Aw value based on your measured value, which can be found on the pdf.