Hurdle Technology & Formulating for Longer Shelf-life

April 30, 2019

Jerry Erdmann
Principal Scientist – Food Protection
DuPont Nutrition and Biosciences

Agenda

Setting Expectation – Cleaner Label AM

How to be Successful

- **-Factors Influencing Growth**
- **-Hurdle Technology**
- **-Holistic Approach to Food Safety and Quality**
- **-Shelf-life and Challenge Studies**

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Clean Label Antimicrobials – What you need to know?

- **Growing customer demand/trend**
- Clean label AM are not 1:1 replacements for chemicals preservatives
- Clean label AM are more targeted – Select the “Right” Tool
- Clean label AM require more attention to detail
- Clean label AM have different sensory and CIU profiles
- Environmental contamination
- Shelf-life and spoilage challenge studies

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Restaurants responding to clean label

- **Subway** – removing all artificial colors, flavors and preservatives
- **Chipotle** – removing all GMO ingredients and targeting the removal of all artificial preservatives
- **Panera** – issued “no-no list” of 150 artificial additives removed from menu items
- **Papa John’s** – removing additives such as MSG, BHA, BHT
- **Pizza Hut** – removing all artificial colors and flavors immediately and mutli-year effort to reduce sodium
- **Taco Bell** – removing all artificial colors, flavors, artificial preservatives and additives

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Source: www.entrepreneur.com

What is Clean Label?

For food manufacturers, it's a balance between the degree of cleanliness they can afford and the market they can work in……

CLEAN LABEL INGREDIENT SPECTRUM

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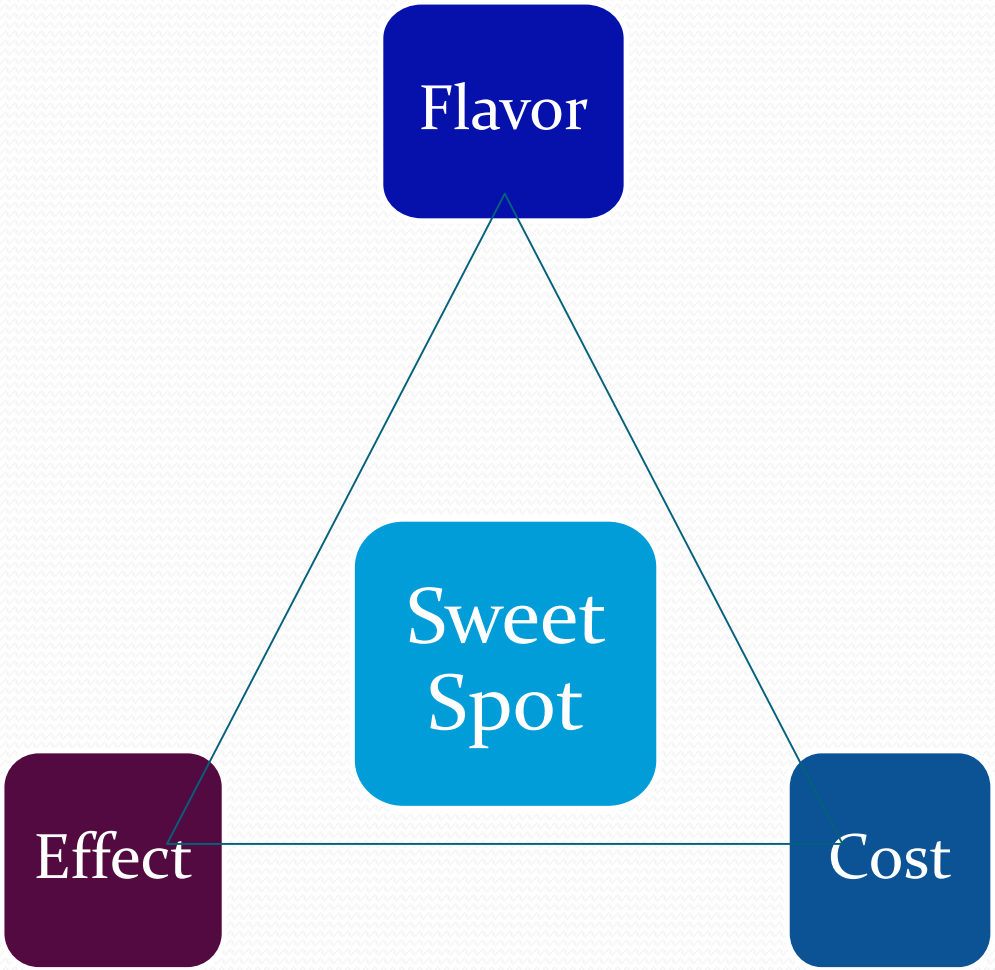
Finding the Sweet Spot



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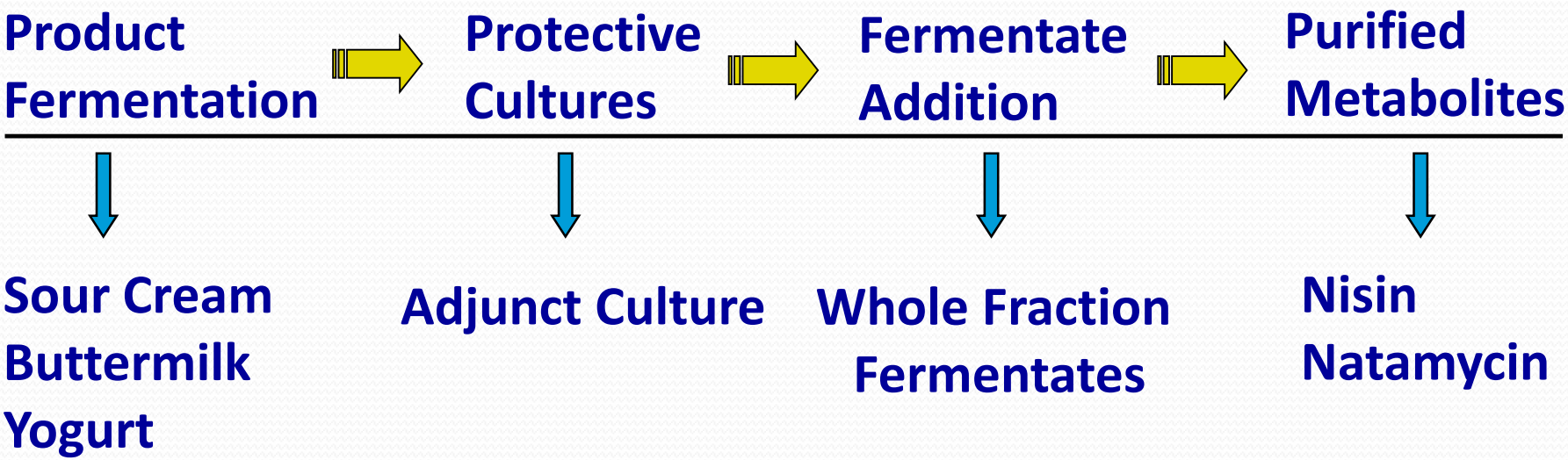
Culture Preservation Formats



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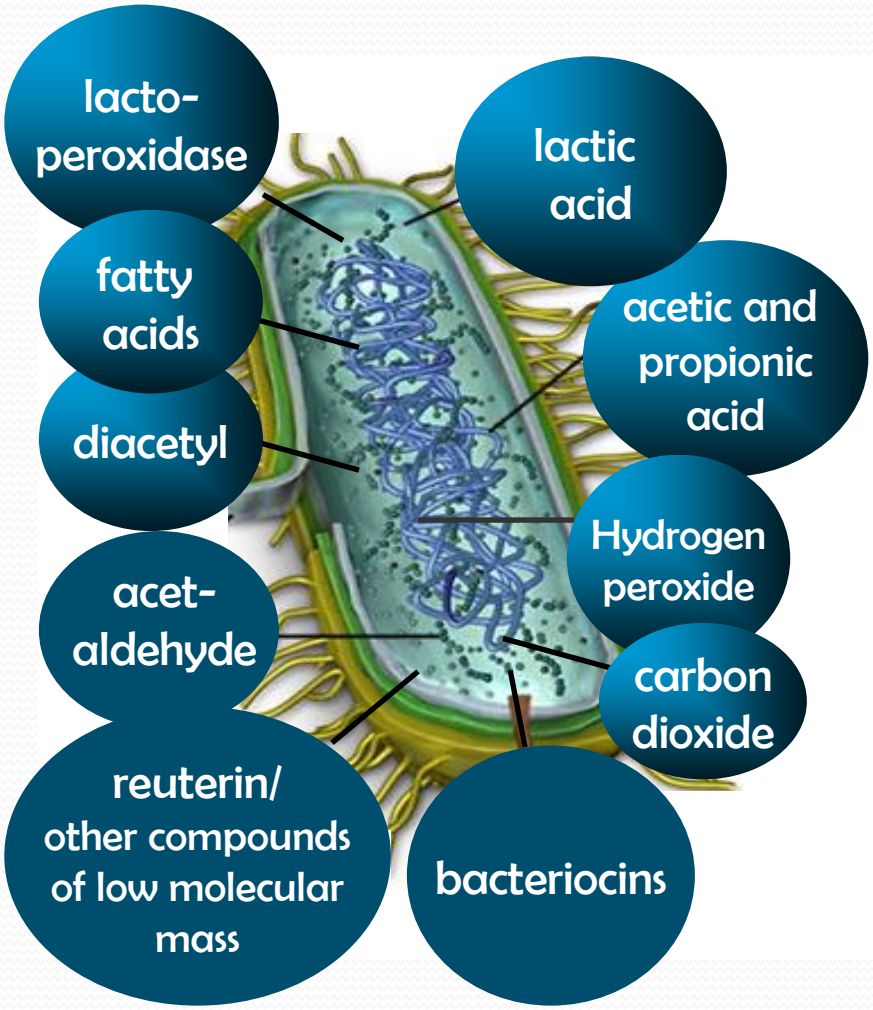
Microbial Whole Fraction Fermentates

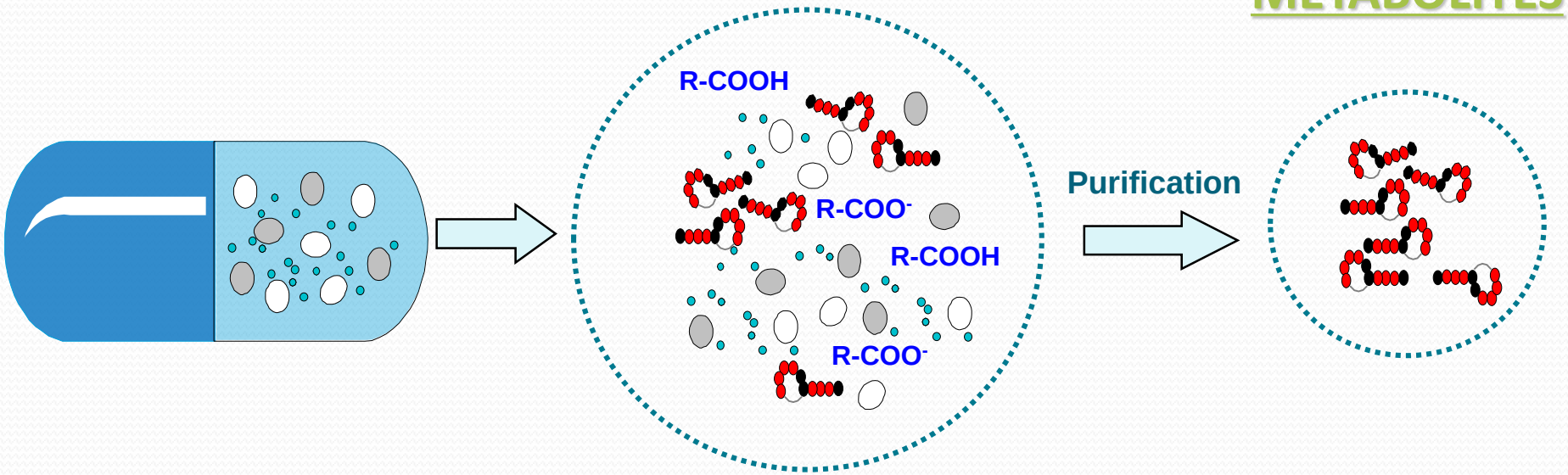


These substances are naturally occurring antimicrobials which by themselves or in combination are highly effective against spoilage and pathogenic microorganisms.

Fermentates

FERMENTATES

PURIFIED METABOLITES



- Cultured Dextrose
- Cultured Whey
- Cultured Non Fat Dry Milk
- Cultured Sugar
- Cultured Wheat Starch

- Nisin
- Natamycin
- Lacticin
- Pediocin
- Sakacin
- Microcin

Plant Extracts Activity

- Composition Depends on:
  - Climate, environmental conditions, time of harvest
  - Commonly named oils from different plant species
  - Extraction method
  - Part of the plant extracted
  - Assay methods

Source: Sara Burt -Essential oils: their antibacterial properties and potential applications in foods – a review

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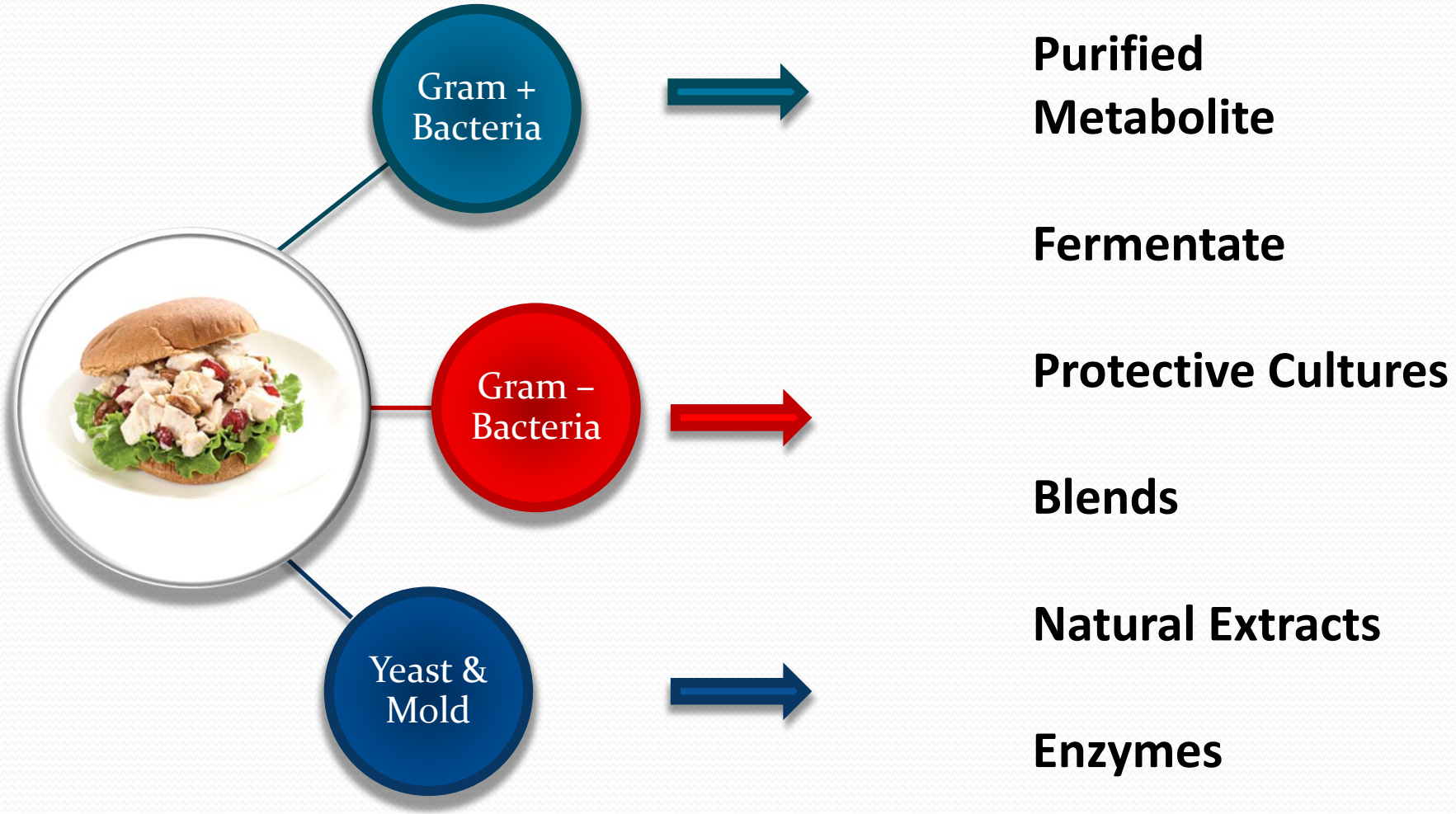
Right Tool: Understanding the Mode of Failure



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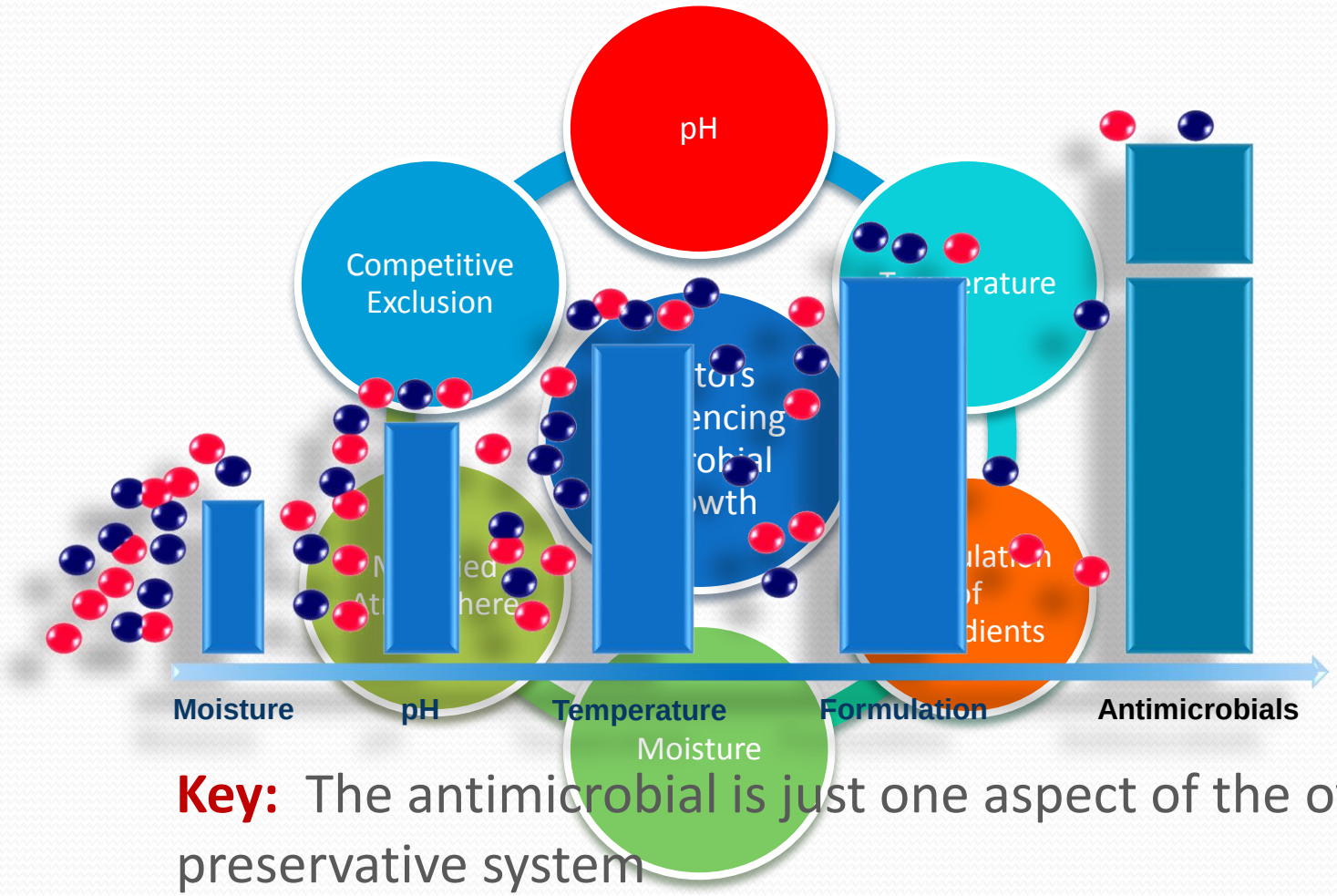
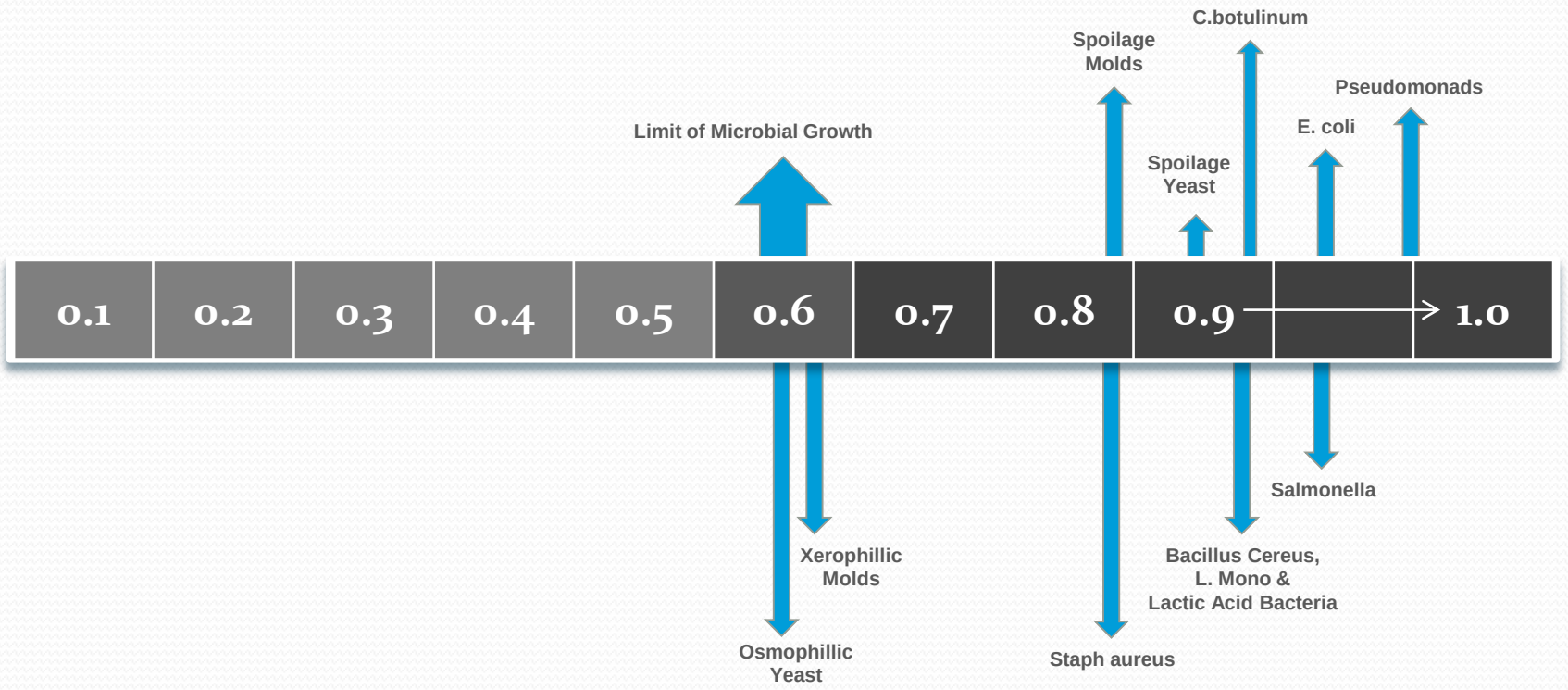
Hurdle Technology: The leveraging of multiple hurdles to compound control over microbial outgrowth and improve safety and stability of the food product.



Key: The antimicrobial is just one aspect of the overall preservative system

Factors Influencing Growth - Example

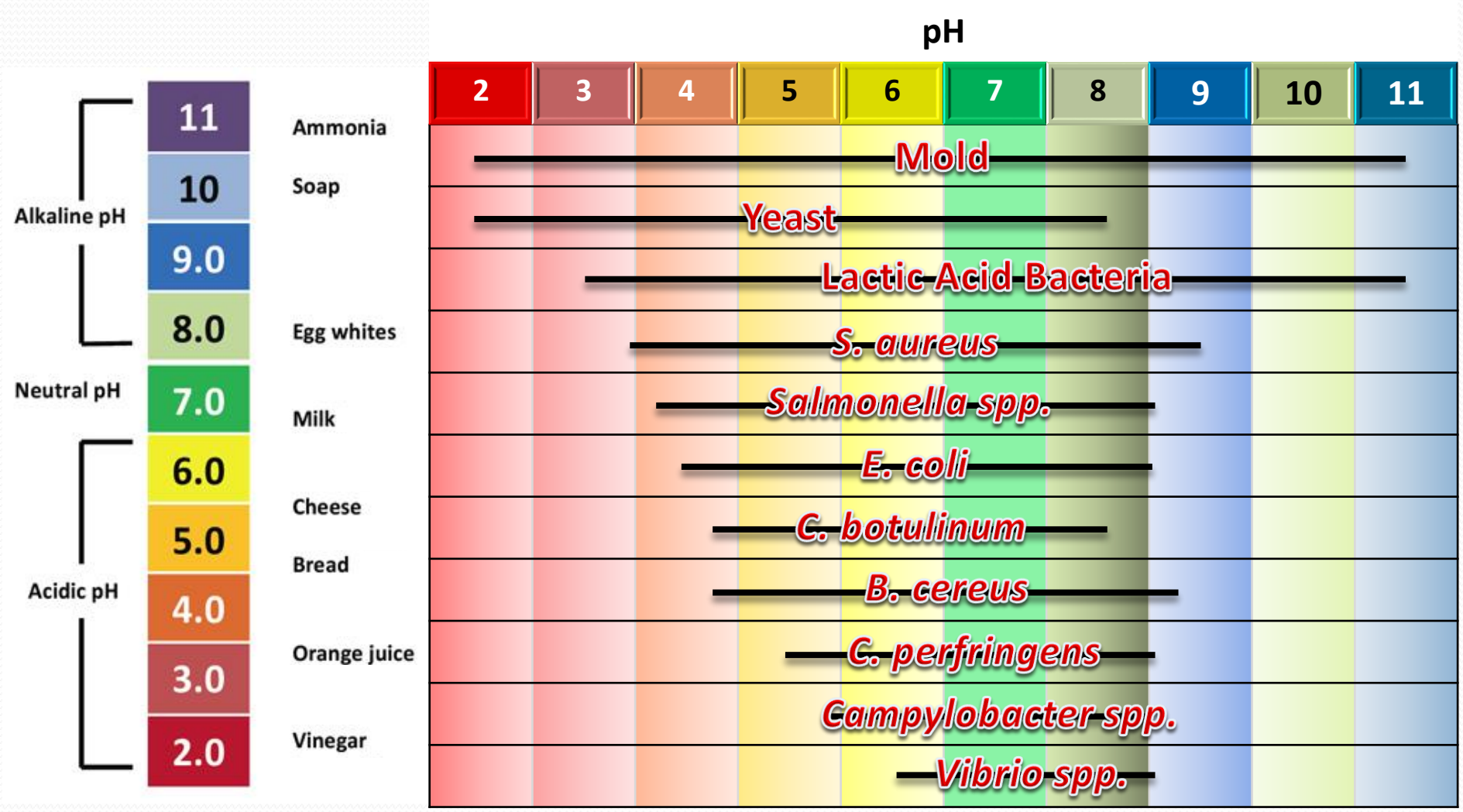
Approximate Minimum Water Activity (Aw) for Microbial Growth



*Risks still may need to be evaluated in areas where no microbial growth is expected

Factors Influencing Growth - Example

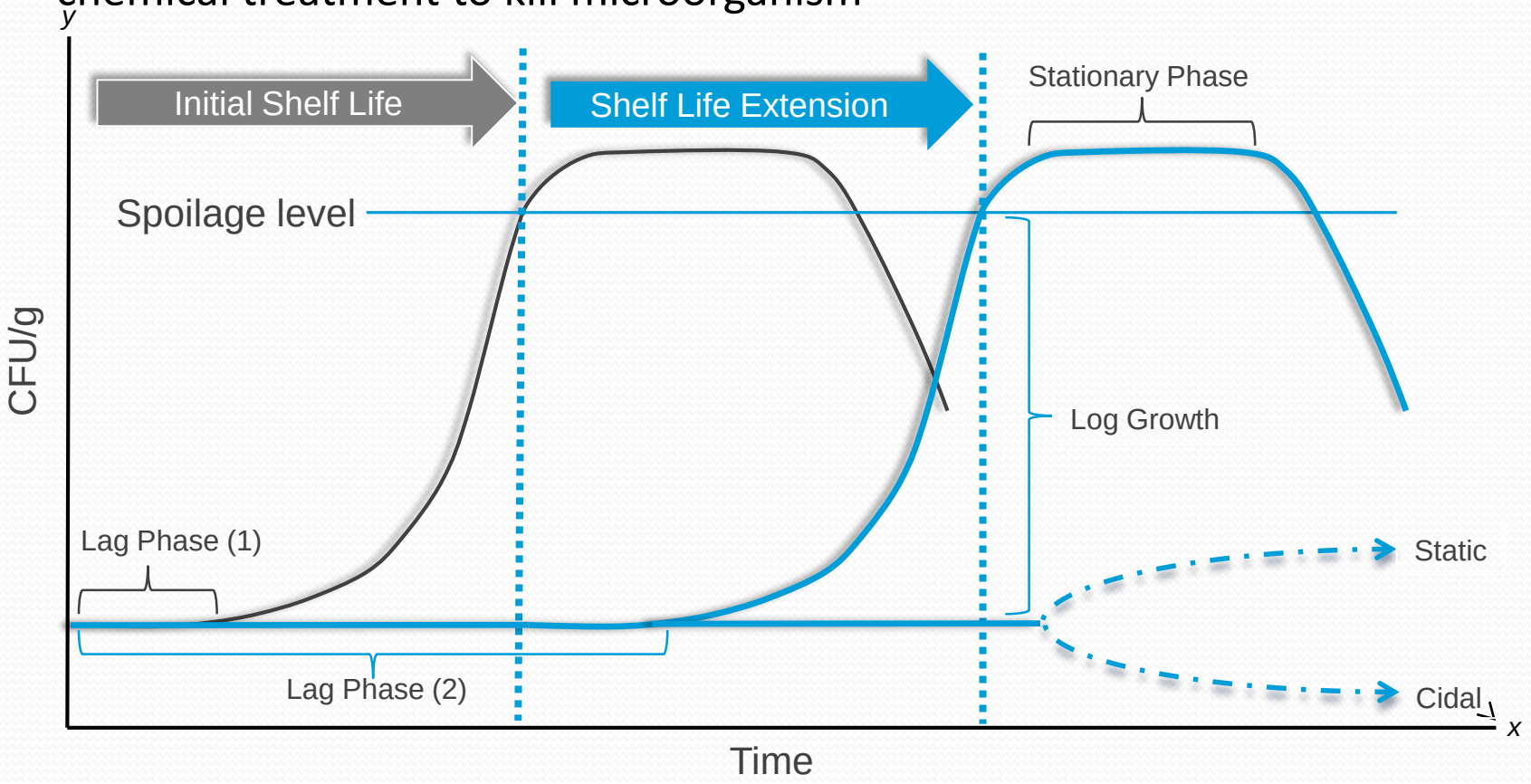
Approximate Minimum pH Values for Microbial Outgrowth



Food Micro Concepts: Growth Phase

Key: Preservative systems could potentially play a static or cidal role in controlling microorganisms over the shelf-life

Key: Cidal tends to describe the effectiveness of a processing or chemical treatment to kill microorganism



Holistic Approach for Safety and Quality

- Raw Materials – Reduce the Incoming Micro Load
  - Spices – Treated
  - Vegetables – Washed /IQF
  - Meat – Cooked/HPP/Fermented
  - Other Raw Agricultural Commodities – Flour, eggs
  - Cultured products
- Processing
  - Process Flow – How the product is put together
  - Processing – Thermal and HPP
  - Packaging – MAP or Vacuum
  - Order of Addition – Hydration and Distribution
- Environment
- Finished Products

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Order of Addition

DO

- ***Hydrate*** any antimicrobials in water, vinegar, lemon juice early in production
- ***Optimize*** the dosage and the addition to the process (earlier is generally better…)
- ***Ensure*** antimicrobial is evenly distributed throughout the product
- ***Order of Addition*** may need to be customized to meet your needs

AVOID

- *Add antimicrobials **directly** into an oil*
- ***Sprinkling** the antimicrobial on top of the product at the end of production*
- ***Excessive** heating*
- *Assumption of no **pH** change*

Holistic Approach for Safety and Quality

- Raw Materials
- Processing
- Environment
  - Environment Monitoring
  - Air Quality
  - Sanitation – Validation
  - Line Run Times
- Finished Products
  - Intrinsic and Extrinsic Parameters – Aw, pH, MAP
  - Robustness of the Product – Hurdles, Strength of Emulsion
  - Single vs. Multi Use

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SPOILAGE Shelf-Life vs. SPOILAGE Challenge Studies

STEP #1: Understanding Shelf Life Evaluations

- Defining clear expectations and objectives on the front end
- What is your target shelf life?
- What is the testing schedule and length?
- What determines spoilage (micro levels)?
- What type of organism(s) spoil your product?
- What should we test for in a shelf life study?

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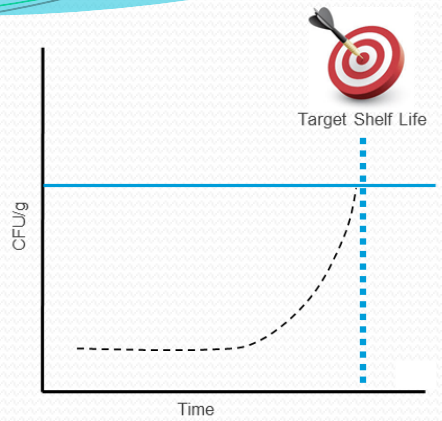
SPOILAGE Shelf-Life



Step #2 – Assumptions

- Final product formula produced in a plant environment with the same potential for contamination
- Consistent initial micro loads
- Formulation differences were minimized as much as possible
- Packaged in commercial containers
- Held at storage temperatures that mimic typical handling

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Spoilage Shelf-life

Step 3: What Does The Shelf-Life Data Tell Us?

Target Shelf Life

Questions/Learnings

- What organisms could potentially spoil your product?
- How micro stable is your current formulation under normal conditions?
- How micro stable is your formulation without preservatives or antimicrobials?

When is a micro challenge study necessary?
A, B, C, D, or It Depends?

SPOILAGE Shelf-Life vs. SPOILAGE Challenge Studies

STEP #4: Understanding Challenge Study Evaluations

- Defining clear expectations and objectives on the front end
- What is the mode of failure/concern on this product?
- How is the product packaged?
- How is the product going to be inoculated?
- What level of inoculum should be used?
- Analytical parameter of the product?
- How will the inoculum be prepared?
- What is the storage temperature?
- Length of the study?
- Testing schedule and frequency?

Selecting Challenge Study Organisms

Order of Relevance

Organisms Isolated from spoiled product(s).

- How micro-stable is your product without any antimicrobial and/or preservative system?
- Has your commercially product spoiled in the past? What caused the spoilage?
    1. Formulation issue(s) (e.g. pH, emulsion issues, etc.)
    2. Processing issue(s) (e.g. heat treatment, excess condensation, etc.)
    3. Introduction of new contaminants or environmentally adapted organisms.

Organisms Isolated from raw ingredients

- Do your raw ingredients increase the risk of spoilage in your products?
- Starting with clean raw ingredients adds an extra hurdle into your process.

Potential environmental contaminants

- Non-food contact vs. food contact surfaces – what's the difference in risk?
- Potential hang up points may be the best place to start your search – why?

Industry standard organisms and/or organisms from literature

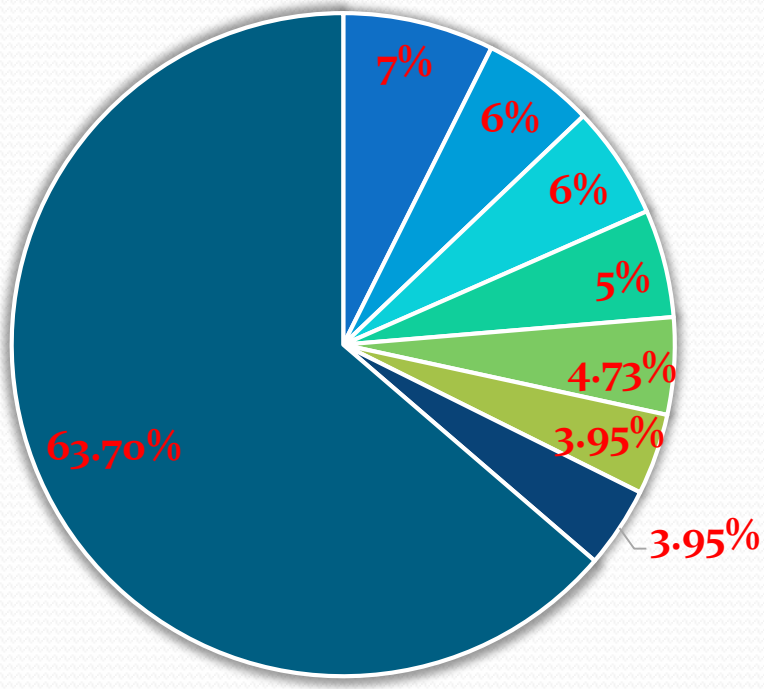
- Are these organisms relevant?

Decrease Value

Commonly Isolated Spoilage Yeasts

Low pH Dressing and Sauces

Most Frequently Isolated Spoilage Yeasts (Low pH Products)



Adapted: 1. Sperber, W., et. al. (2009). *Compendium of the Microbiological Spoilage of Foods and Beverages.* New York: Springer

Spoilage Challenge Study

Balancing Risk and Relevance

Organism Selection

"During product research and development, it is advisable to conduct challenge tests in which various product formulations are inoculated with **representative spoilage microorganisms**. It is preferable to use cultures of spoilage microbes that have been recently isolated from **spoiled containers** or **similar products**, rather than cultures that have been carried in the laboratory for many years or obtained from a reference culture collection" (1)

1. Sperber, W., et. al. (2009). *Compendium of the Microbiological Spoilage of Foods and Beverages.* New York: Springer

Spoilage Challenge Study

Balancing Risk and Relevance

Recommended Inoculum Levels

"The combined inoculum level should provide a relatively low level of microbes in the test samples, on the order of **10^2 - 10^3 microbes/g**. This controlled low level of inoculum is higher than that which would usually occur during normal production so that it provides a sufficient challenge to the food. It is also low enough to avoid the creation of microenvironments in which clusters of spoilage microorganisms could overwhelm the preservative factors present in the food and grow to levels capable of spoiling the product." (1)

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SPOILAGE Challenge Study

Step #5 – Assumptions

- Final product formula produced in a plant
- Minimize formulation differences
- Packaged in commercial containers
- **Pre-determined parameters that may be slightly abusive**
- Relevant organisms and inoculation levels
- Necessary controls will be in place

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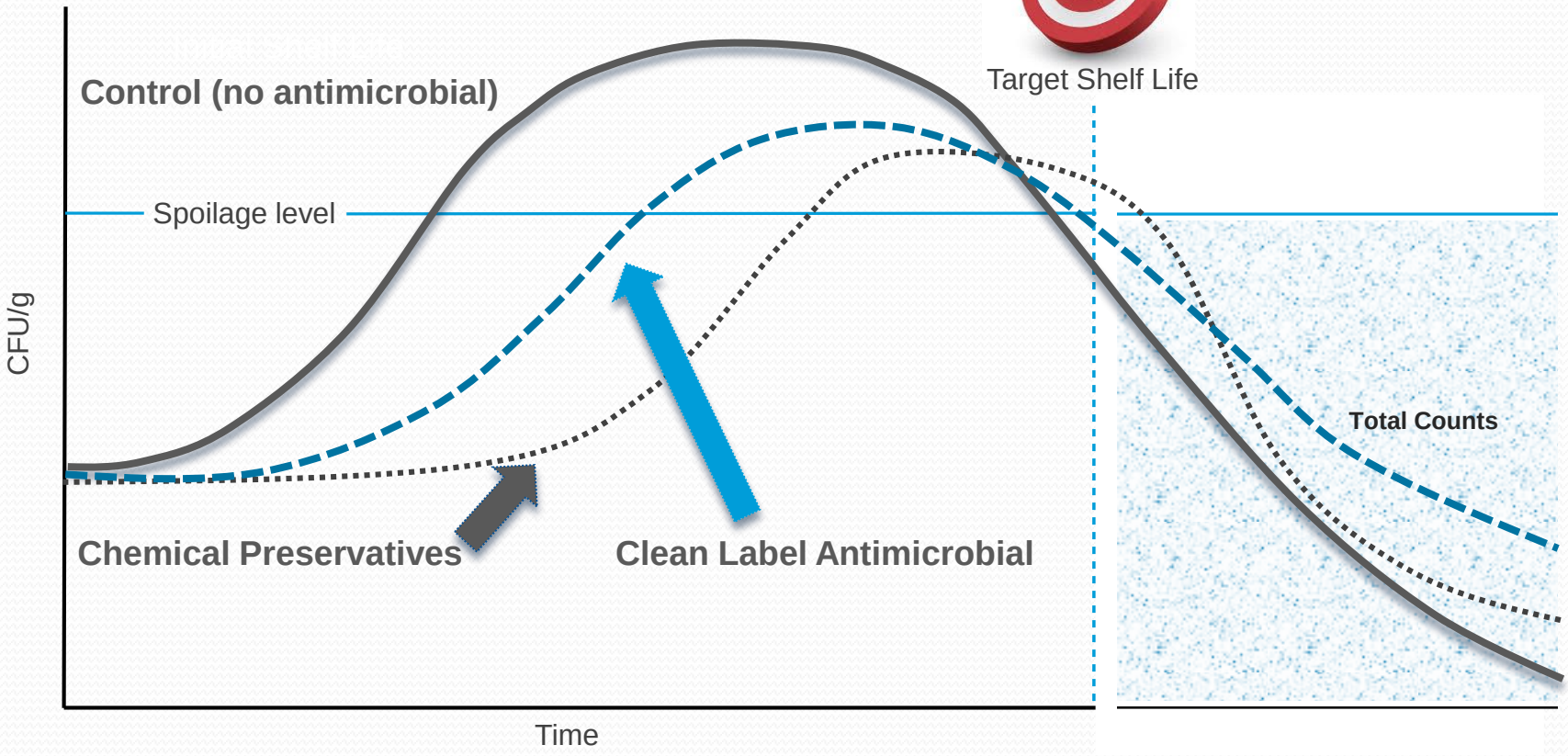
Spoilage Challenge Study

Step #6 – What does a spoilage challenge study tell you?

How robust is your solution?

Target Shelf Life

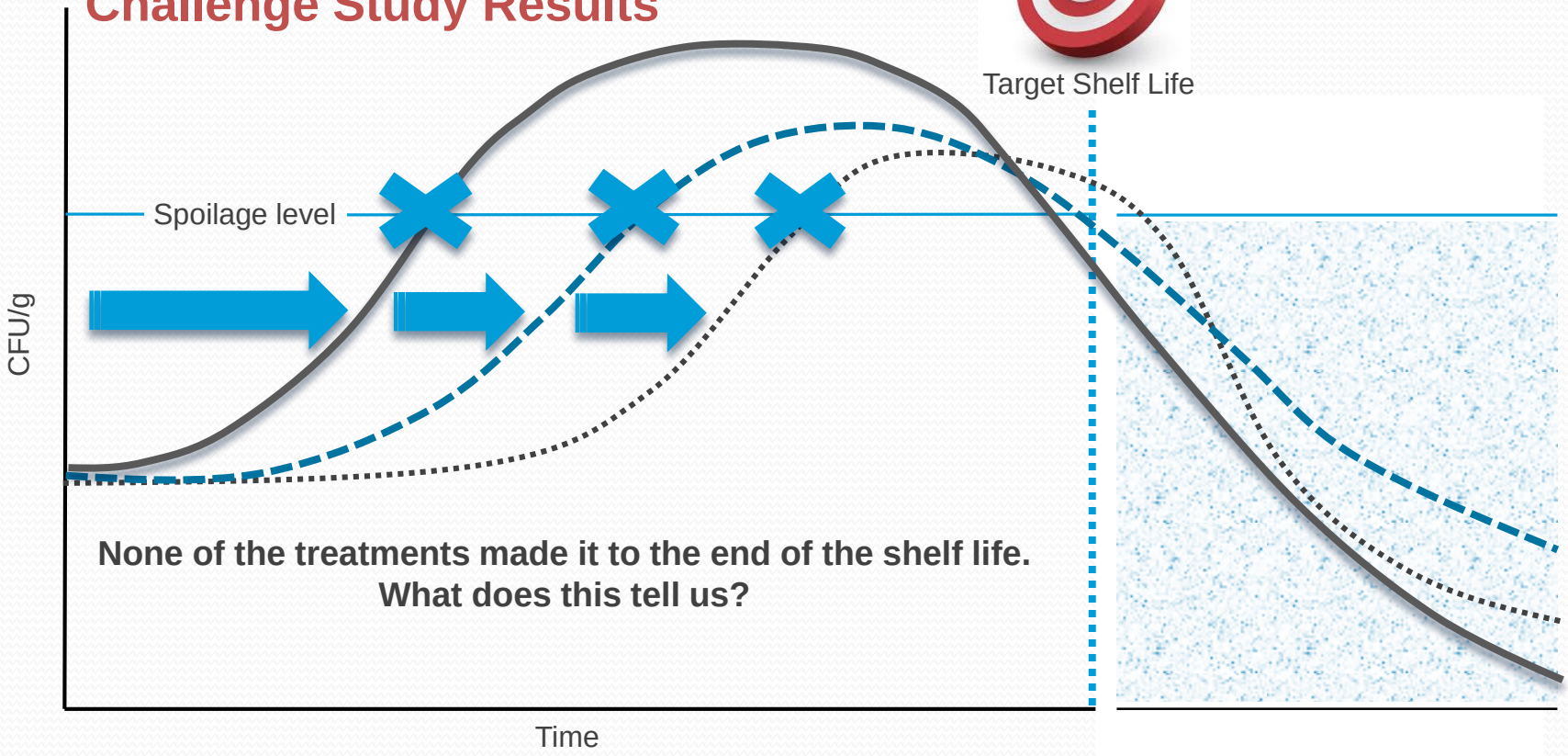


Spoilage Challenge Study

How Robust is your solution?

Target Shelf Life

Challenge Study Results



None of the treatments made it to the end of the shelf life.
What does this tell us?

Challenge studies indicate the robustness of your solution under a pre-determined set of conditions.

Summary

Steps to obtain longer shelf-life

- ✓ Know who / what you're up against, i.e. the specific organisms.
- ✓ How many are there? (e.g. initial vs. end of shelf life micro loads)
- ✓ Find the "Right" tool for the job
- ✓ Application of the "Right' tool
- ✓ Leveraging the intrinsic and extrinsic parameter to develop a robust antimicrobial system (i.e. develop product hurdles)
- ✓ Utilizing a holistic approach to food safety and quality
- ✓ Performing relevant product validation
- ✓ Remember there are ***NO*** silver bullets for food safety or shelf life extension.

Bringing Value to the Food Industry

Cleaner Label

Increased Shelf-life

Expanded Distribution

Increased Brand Exposure

Value Creation

Brand Protection

Improved Product Quality

Reduced Returns/Risk

Improved Brand Image

Value Creation

Questions…