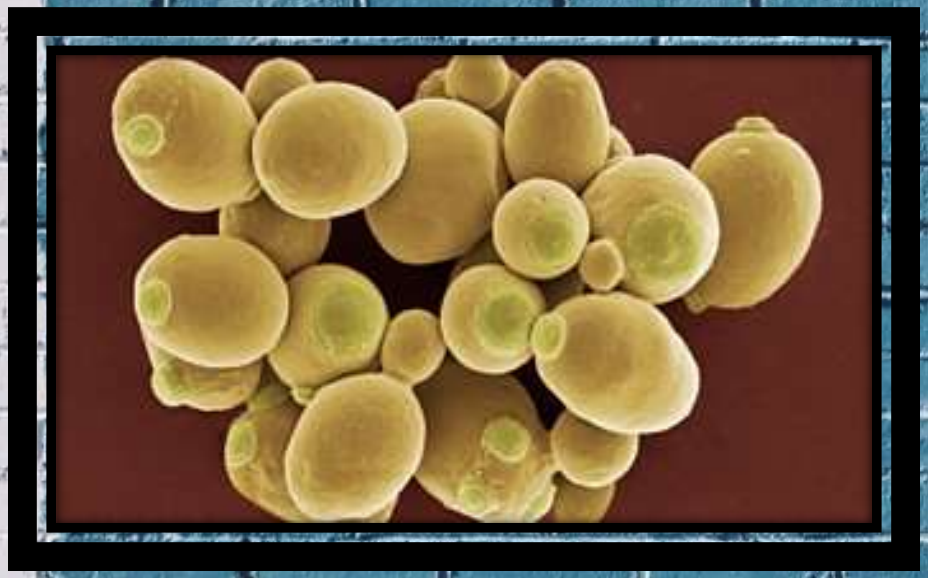
DIVERSITY AND CONTROL OF SPOILAGE FUNGI IN DAIRY PRODUCTS

Introduction

Fungi

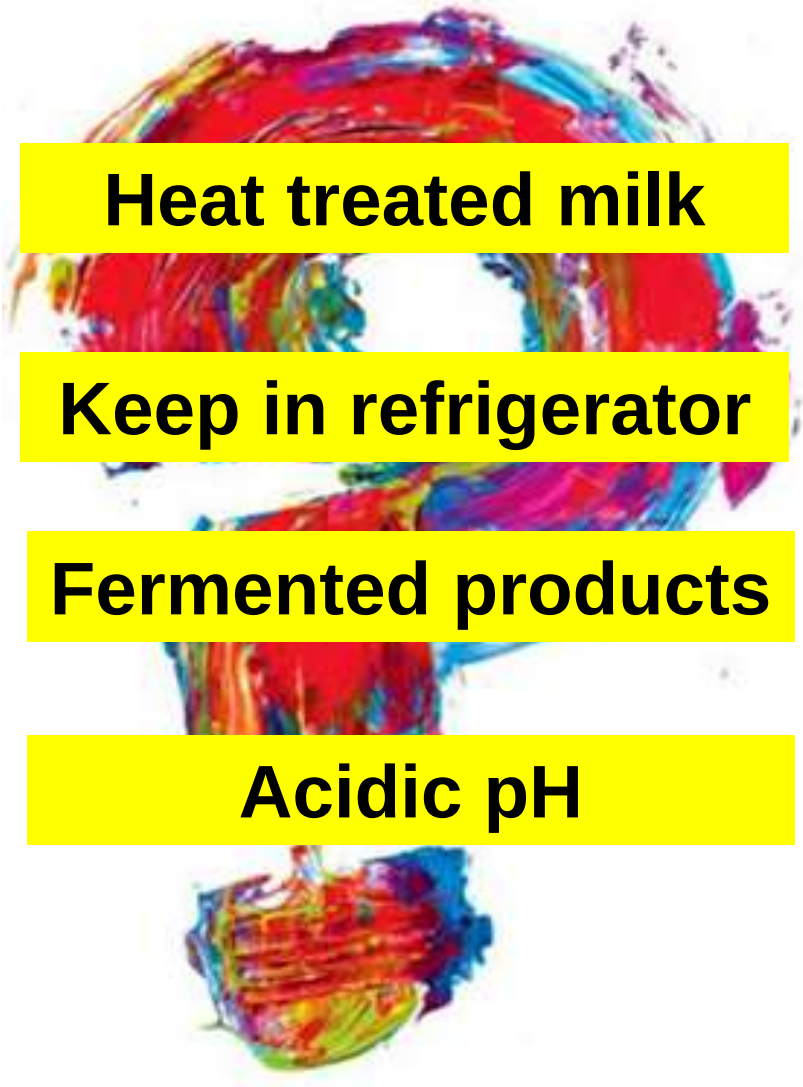


Yeast

Mold

Estimated that 5% - 10% of the world's food production is lost due to fungal deterioration

Dairy Product are less susceptible to fungal spoilage



Heat treated milk

Keep in refrigerator

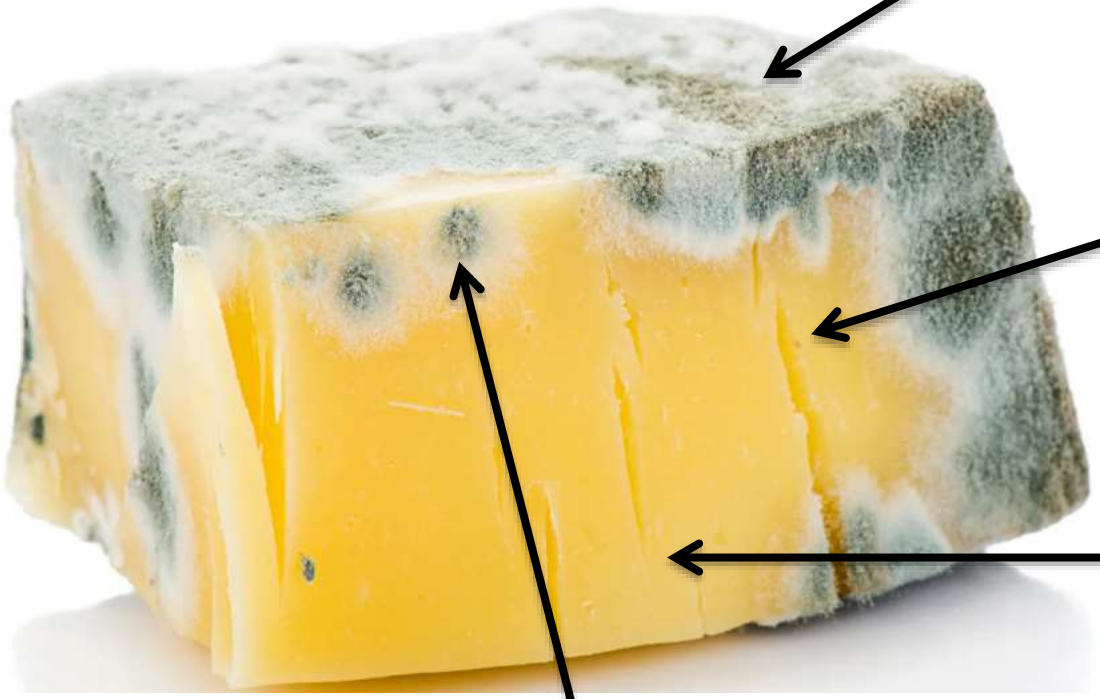
Fermented products

Acidic pH

Undesirable Species

Penicilium spp.

Aspergillus spp.



Visible growth of fungus at product surface

Off odour and flavors

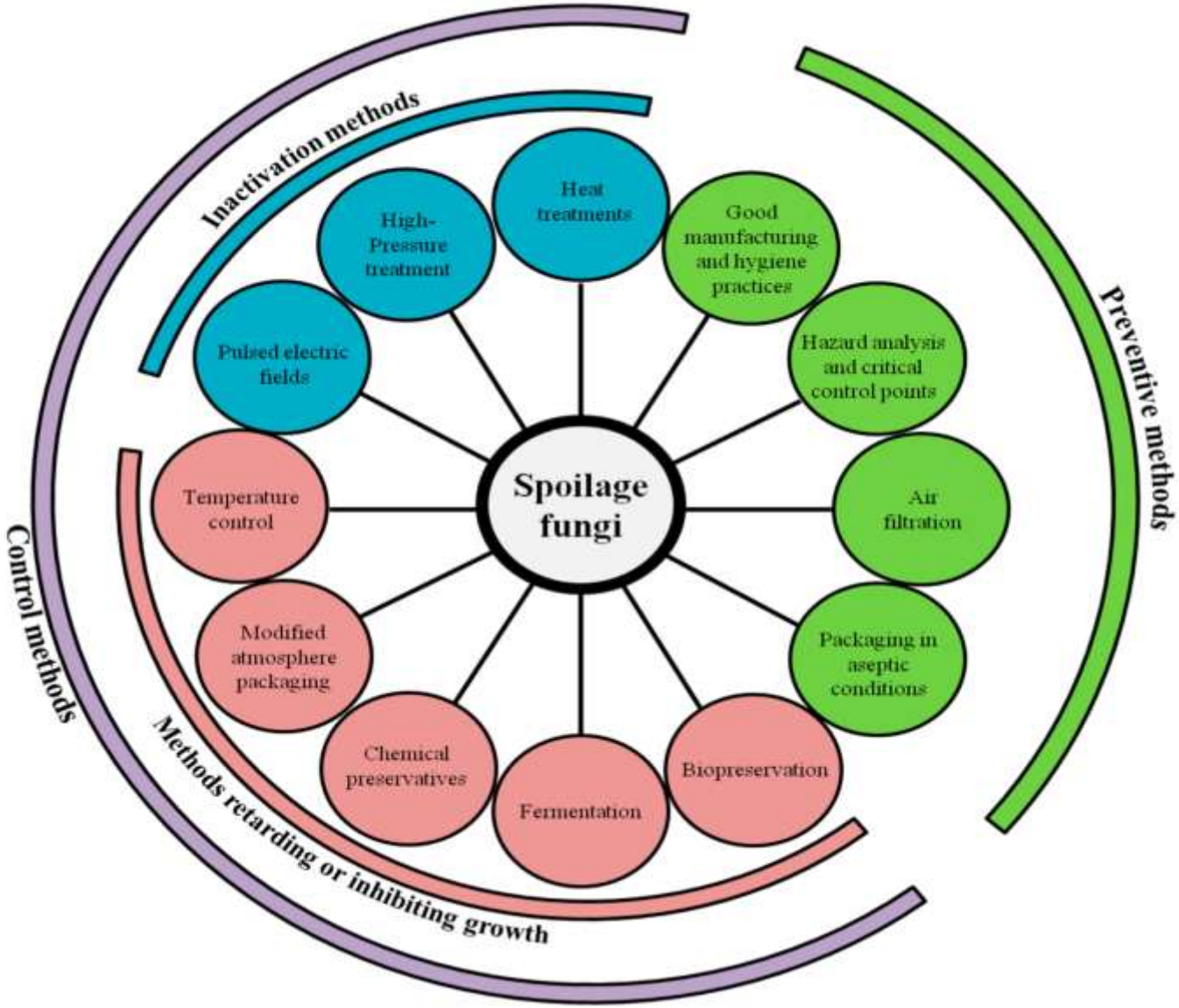
Visible changes in colour and texture

Mycotoxins

Sources of Fungal Contamination

- The Stable and milking parlor environment
- Customer's improper handling and care
- Teat surface
- Airborne Fungi
- Packaging Materials
- Cheese Rind
- Contaminated surface, equipment, or ingredients

Prevention and Control of Fungal Spoilage in Dairy Product



Preventive and control method used in dairy products

Preventive Methods

Good Manufacturing and Distribution Practice

Two essential points:

i. Selecting good quality raw materials and monitoring the manufacturing process to prevent cross contamination
ii. Avoid or retard microbial growth

This code relies on the use of GHP, HACCP and other Prerequisite Programs (Total Quality Management, TQM)

Preventive Methods

Air Filtration and Decontamination System

- Effective air-filtration system to reduce spore counts into the air where the product is vulnerable.
- Carefully examine the direction of the air flows and the location of outlets.
- Control of air pressurization to prevent air flow from dirtiest to cleanest zones
- Cleanroom technology

- Air decontamination
  - Example: Alcohol, aldehydes, chlorine based agents.
  - Combination of disinfectants

Control Methods

- Inactivation Treatment
- Temperature Control
- Modified Atmosphere Packaging(MAP)
- Chemical Preservatives

Inactivation Treatment

- Heat Treatment
- High Pressure Treatment
- Pulsed Electric Field

HEAT RESISTANCE

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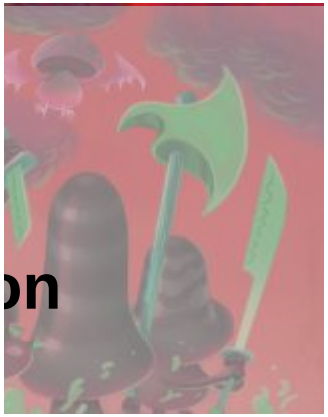

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High Pressure Treatments

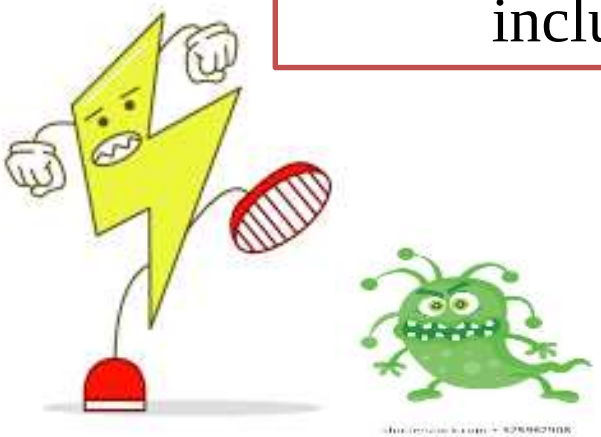
- **Inactivate yeast cell and mold spores**
- **Extend product shelf life**
- **No significant changes in protein and lipid structure to the products**

Meets consumer's expectations for more "natural" and less heavily processes food products

Pulsed Electric Fields

Efficient non-thermal food processing technique using short, high voltage pulses

Used for microbial inactivation include yeast and mold



Temperature Control

Low Temperature

Minimize the growth in raw milk until processing and to extend the shelf life of non-sterile dairy food.

Physchrotrophic fungi have the ability to growth at refrigerated temperature

Beside storage temperature,

The spoiler initial population and the time required to form thallus on the products surface will also determine the fungi spoilage susceptibility

Modified Atmosphere Packaging

Replacement of air by a defined gas mixture

Control fungal spoilage and extend dairy food shelf life

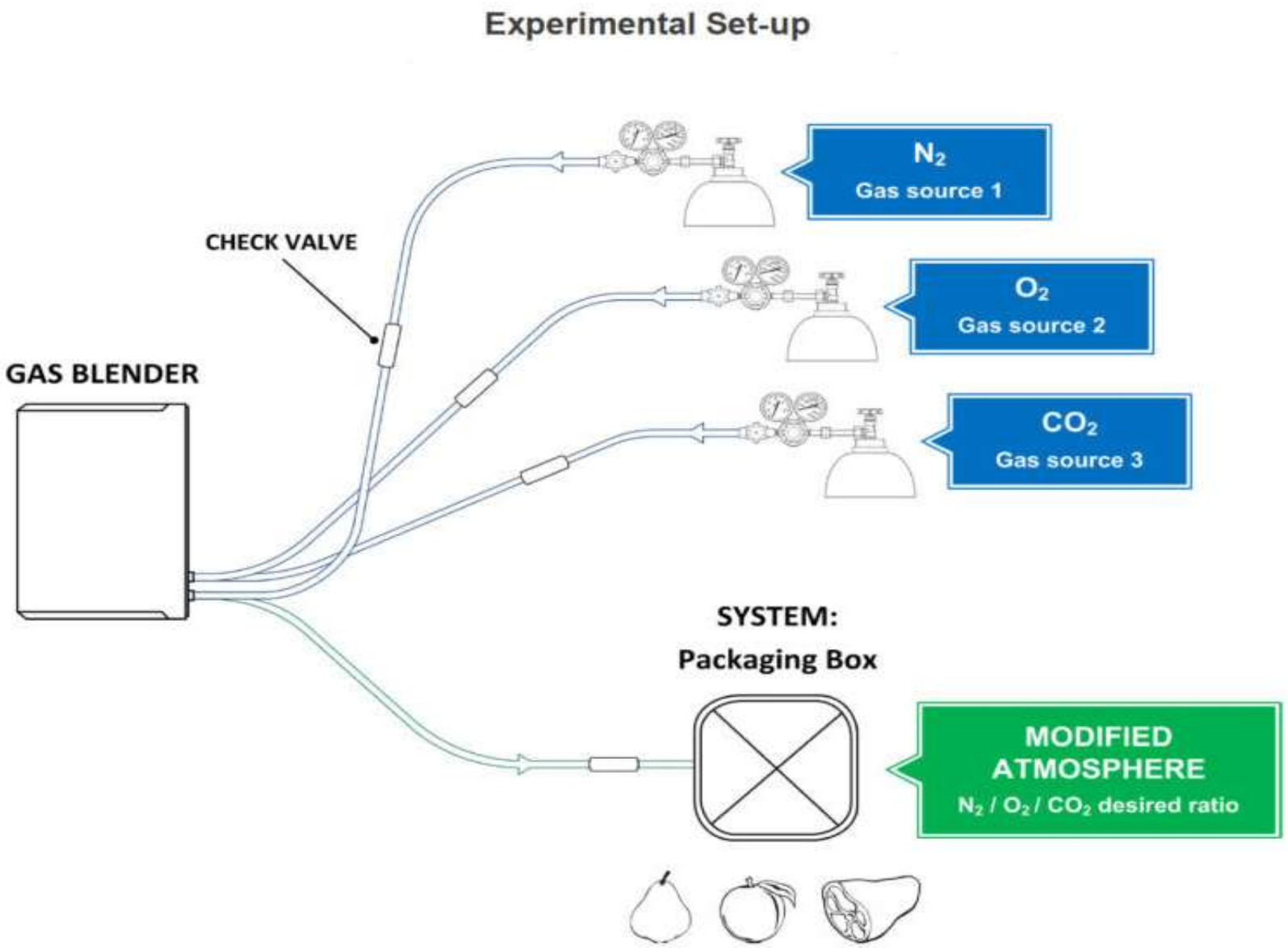
Example:

Lowering Oxygen Level

- **Inhibit partially the growth of strict aerobic fungi**
- **Slow down facultative anaerobes growth**

Increasing CO2 Level

- **Antimicrobial Effect**
- **Inhibit fungal growth**
- **Decrease in pH. Why?**

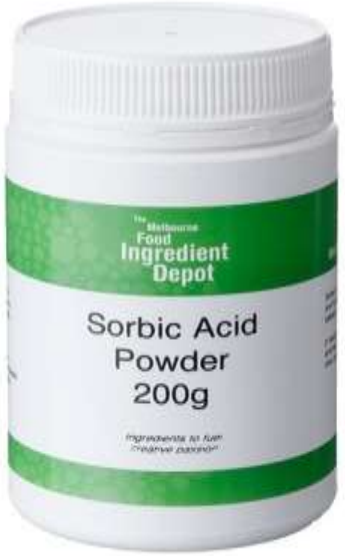


Picture show the Experimental Set Up for MAP

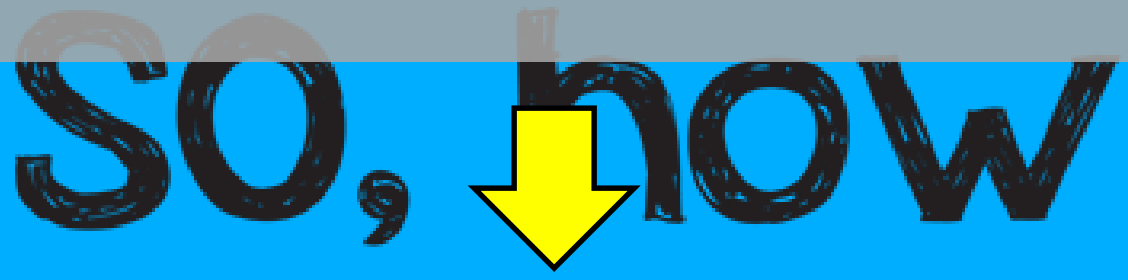
Chemical Preservatives

Preservatives include weak organic acids (sorbic acid, benzoic acid) and salts (potassium sorbate, sodium benzoate)

Sorbic and **Benzoic acid** have an optimal inhibitory activity at pH 4.5-5.5



The uncharged, undissociated acid form can diffuse freely across the cytoplasmic membrane and enter into the cell



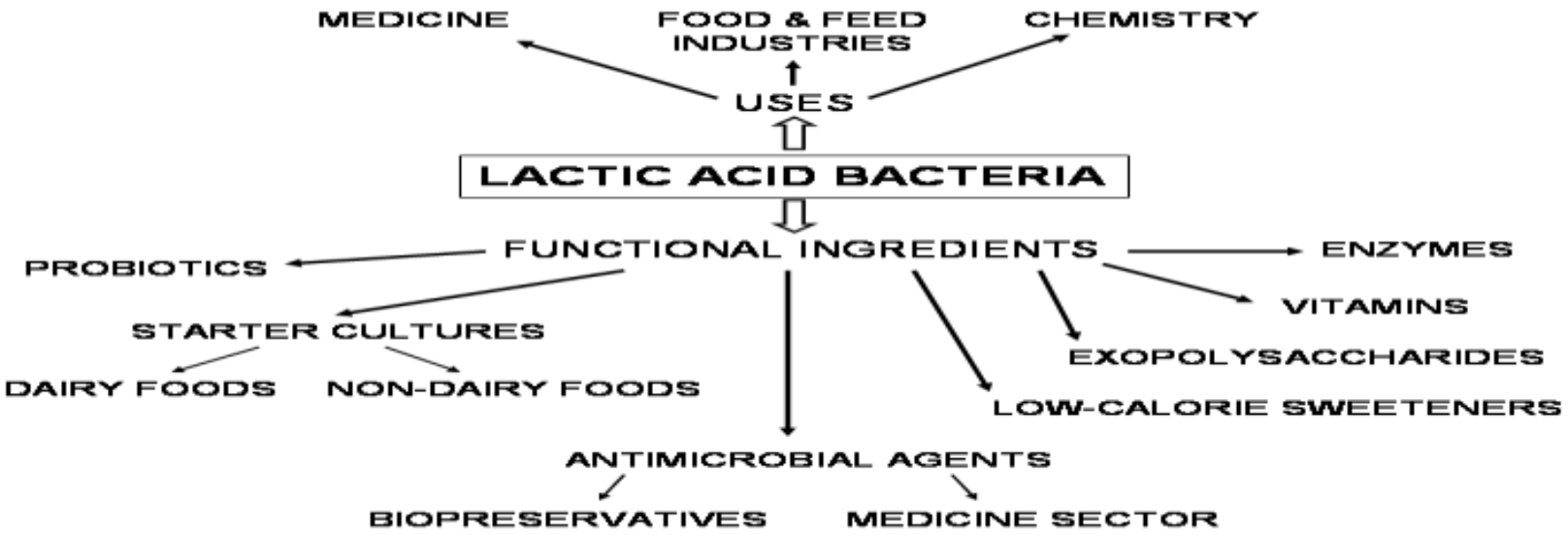
Once inside the cell, the acid will dissociate and release charged anions and protons

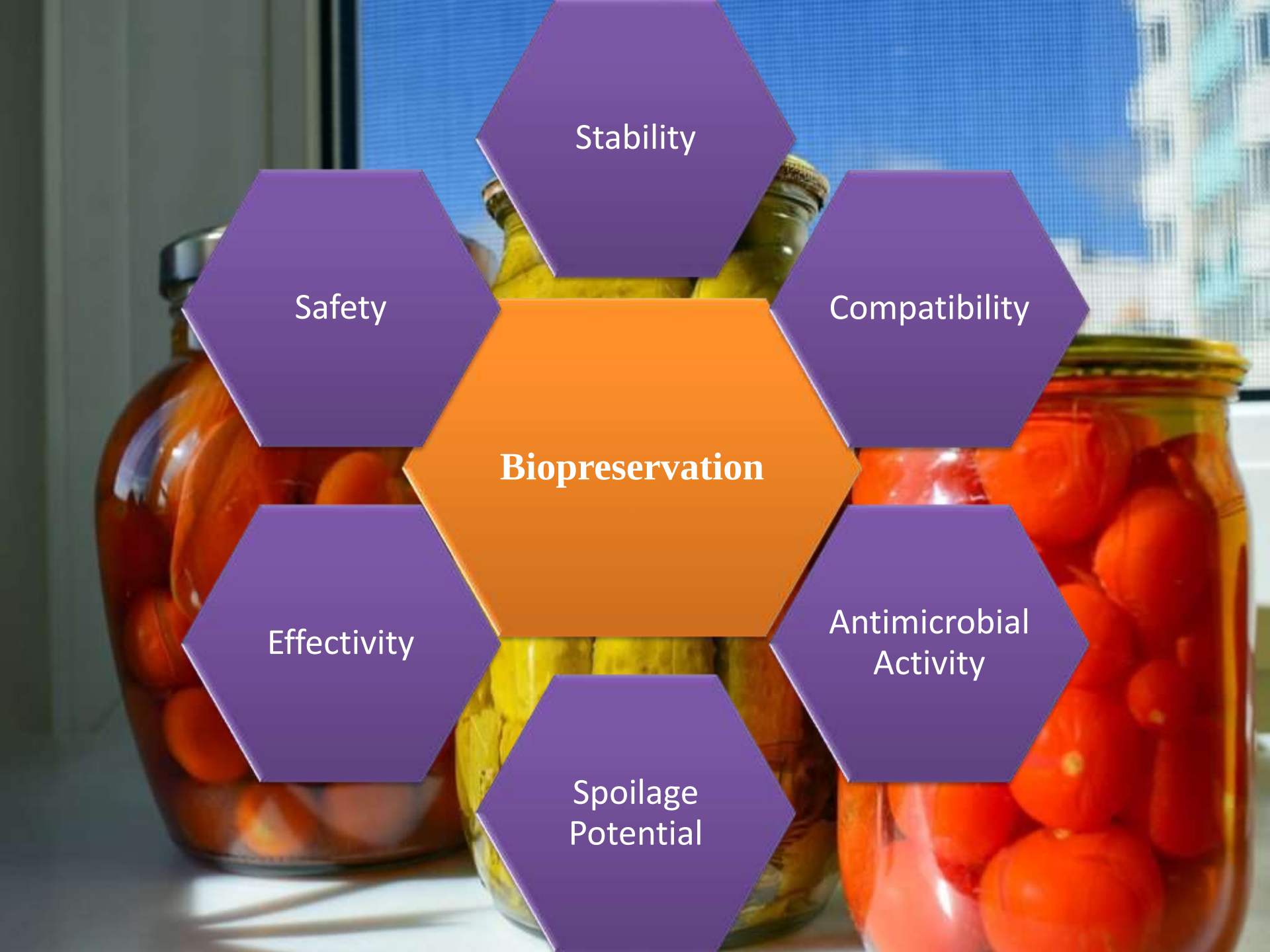
Anions and protons accumulation into the cell is responsible for intracellular pH decrease and may cause membrane disruption which finally lead to cell death.

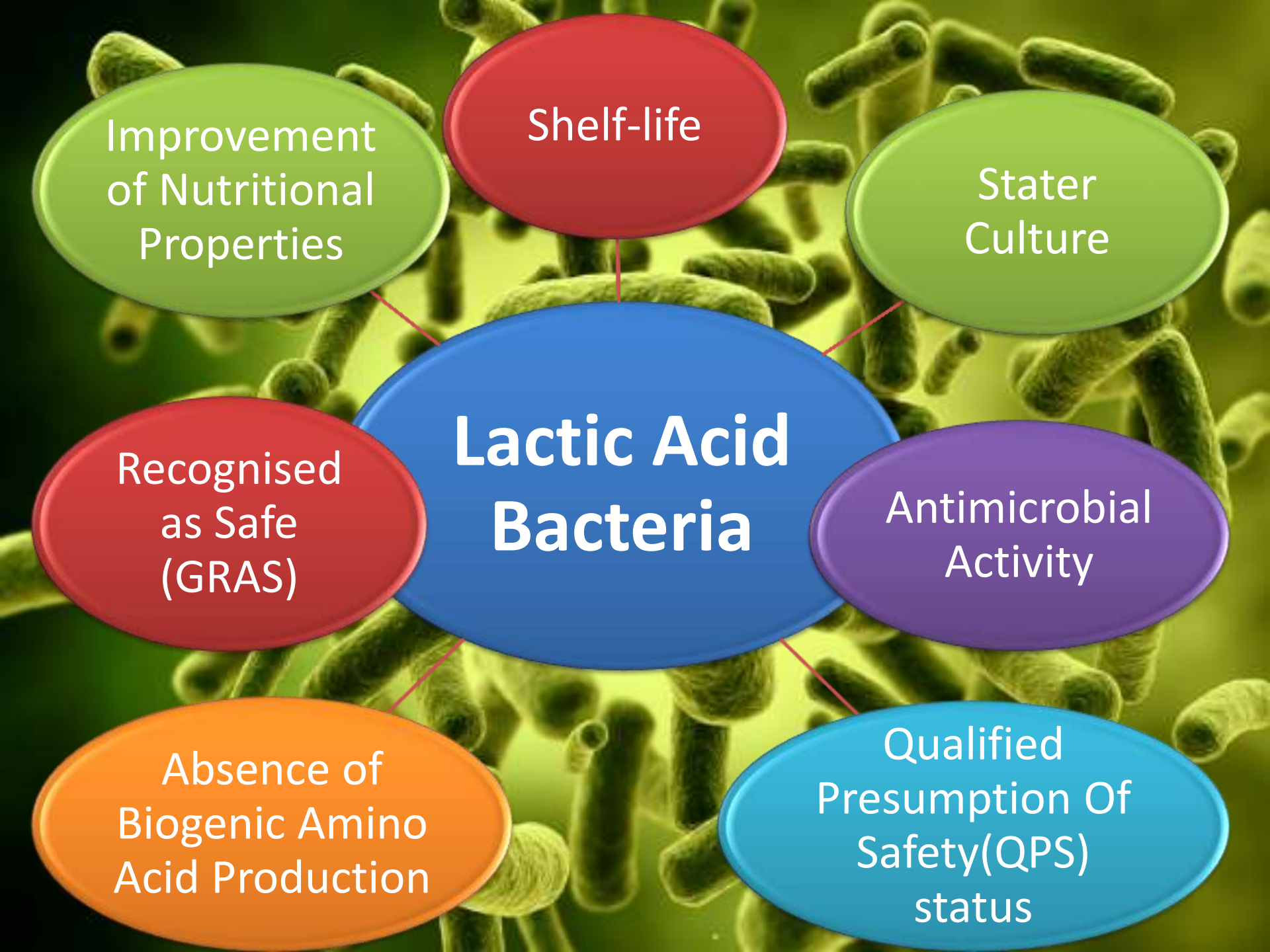
Fermentation

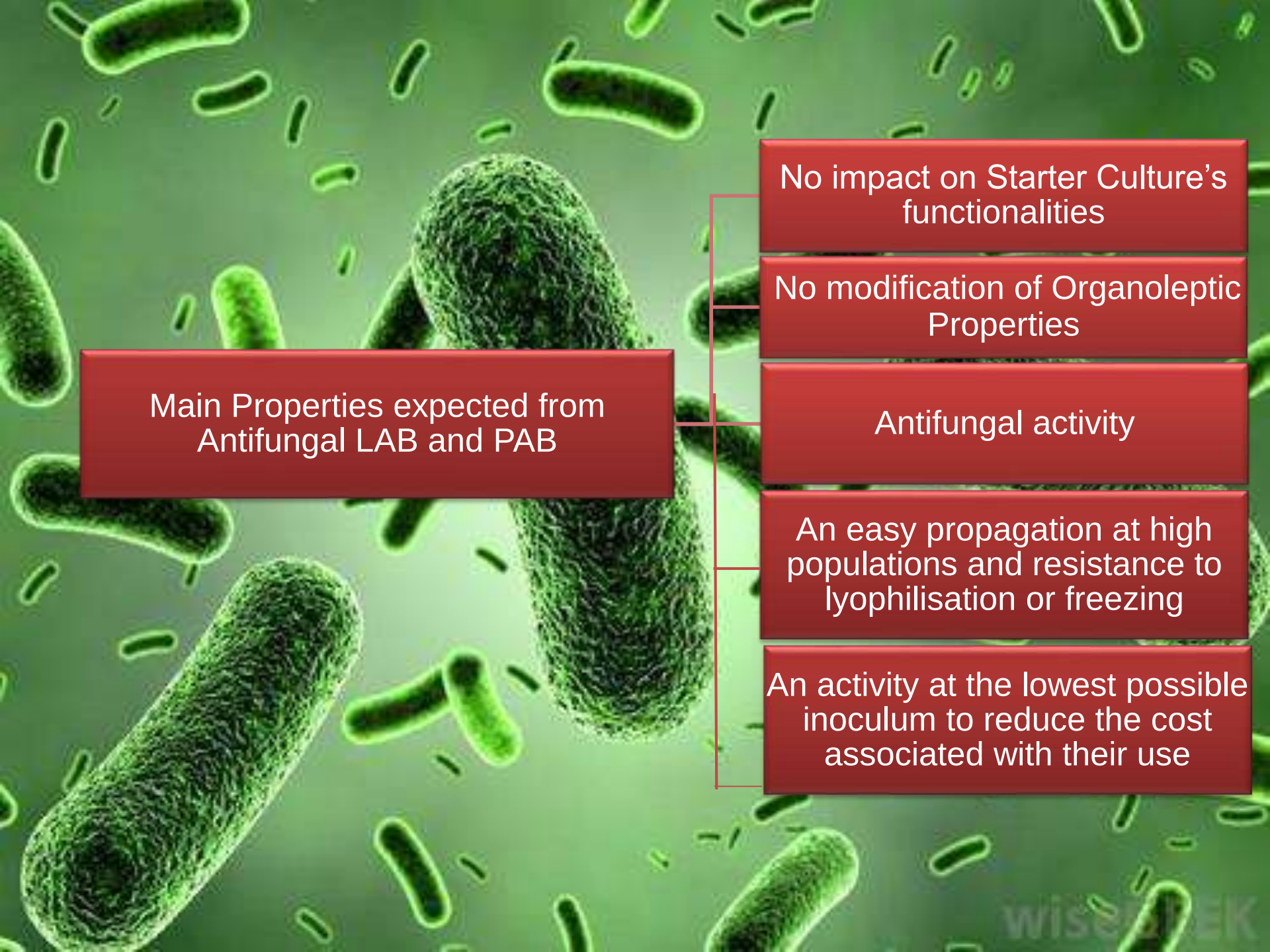
The oldest preservation methods

Microbial groups involved in dairy product manufacturing may suppress or retard the growth of spoilage fungi




Stability
Safety
Compatibility
Biopreservation
Effectivity
Antimicrobial Activity
Spoilage Potential


Improvement of Nutritional Properties
Shelf-life
Stater Culture
Lactic Acid Bacteria
Recognised as Safe (GRAS)
Antimicrobial Activity
Absence of Biogenic Amino Acid Production
Qualified Presumption Of Safety(QPS) status


Main Properties expected from Antifungal LAB and PAB
No impact on Starter Culture's functionalities
No modification of Organoleptic Properties
Antifungal activity
An easy propagation at high populations and resistance to lyophilisation or freezing
An activity at the lowest possible inoculum to reduce the cost associated with their use

Antifungal Bioprotective Cultures

- Commercially Produced Antifungal Bioprotective Cultures are:
- **HoldbacYM-B** (DuPont Danisco)(mixed culture of *Lactobacillus rhamnosus* and *Propionibacterium freudenreichii* sub sp. *shermanii*)
- **FreshQ® series** (Dupont)(single *L. rhamnosus* culture)
- **Befresh™AF** (Handary)(mixture of *Lactobacillus paracasei* and *P. freudenreichii* sub sp. *shermanii)*

Screening For Antifungal Strains

- Culture of *Lactobacillus* species in Man, Rogosa, and Sharpe (MRS) media to detect antifungal activities (154 starins) against *R. mucilaginosa* and to a lower extent against *Aspergillus tamari*, *Candida krusei*, and *K. marxianus*.
- Plate raw milk samples on semi-selective media for LAB to develop an antifungal isolate collection, and using the agar-overlay method to systematically screen colonies for their antifungal activity against four spoilage fungi.

Antifungal Activities Against Fungi

- **Bacterial species that have shown the antifungal acivity:**
- *Lactobacillus*
  (L. plantarum, L. casei, L. paracasei, L. brevis)
- *Propionibacterium,*
- *P. freudenreichii*
- *Lactococcus*
- *Pediococcus*
- *Weissella*
- *Leuconostoc*
- **Target fungal species:**
- *Penicillium, Candida, Kluyveromyces, Rhodotorula* spp., *Debaryomyces hansenii* and *Yarrowia lipolytica*

Major Species

To a smaller extent, most frequently cited genera

Factors That Affecting the Antifungal Activity

❖Intrinsic factors:

- Medium composition in terms of macro- and micronutrients
- pH
- aw
- Eh
- Food structure

❖Extrinsic factors:

- Temperature
- Composition of the surrounding atmosphere
- Humidity

Antifungal Activity Test

Testing of efficiency in real products using challenge and durability-tests and against one or several fungal targets.

Delavenne Method

The antifungal activity of *Lactobacillus harbinensis* KV931Np against six fungal targets in yoghurt

Schwenninger and Meile Method

The antifungal activity of three mixed cultures of *Lactobacillus paracasei* subsp. *paracasei* SM20, SM29, or SM63 and *Propionibacterium jensenii* SM11, against *Candida pulcherrima*, *C. magnoliae*, *C. parapsilosis*, and *Zygosaccharomyces bailii* in yoghurt and on cheese surfaces.

Aunsbjerg Method

The antifungal activity of *Lactobacillus paracasei* in chemically defined medium and in yoghurt against *P. solitum* and *Penicillium* sp.

Fermentates

- Fermentates, which are fermented dairy ingredients produced from milk, containing antifungal metabolites.
- MicroGARD (DuPont Danisco) and DuraFresh (Kerry) are two currently available commercial fermentates
- The use of this fermentate in cottage cheese partially inhibited *K. marxianus* and *P. expansum* and thus extended its shelf-life. It may also be used in sour cream, yoghurt, and dairy desserts.

Review

1. What is fungi?
2. Sources of contamination
3. Preventive and Control of Spoilage in Dairy Products

- Inactivation Treatments
- Temperature Controls
- MAP
- Chemical Preservatives
- Fermentation

4. Bioprotective Cultures


Thank You