The natural mechanism behind food cultures with high bioprotective effect

Mejeriteknisk Selskab Seminar: Ingredients in dairy products

04-03-2021

Stina Dissing Aunsbjerg Nielsen

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Using nature’s good bacteria to ferment food is a traditional way to keep food fresh longer

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Bioprotection benefits

Keep waste down.

29 mil. tonnes
of dairy products are wasted every year in Europe alone

20%
of all dairy food

60 bill.
Euros wasted

Source: UN Food Waste Eurostat Data

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A technique based on traditional principles

- Fermentation by food cultures has been known from ancient time as a natural way of preserving food
- Bioprotection is developed based on the traditional principles
- It is the art of using natural microbial food cultures to help slow down growth of unwanted contaminants – helping to reduce food spoilage and enhance food safety
- We use our superior knowledge of food microbiology to identify and select suitable lactic acid bacteria for bioprotection in dairy food

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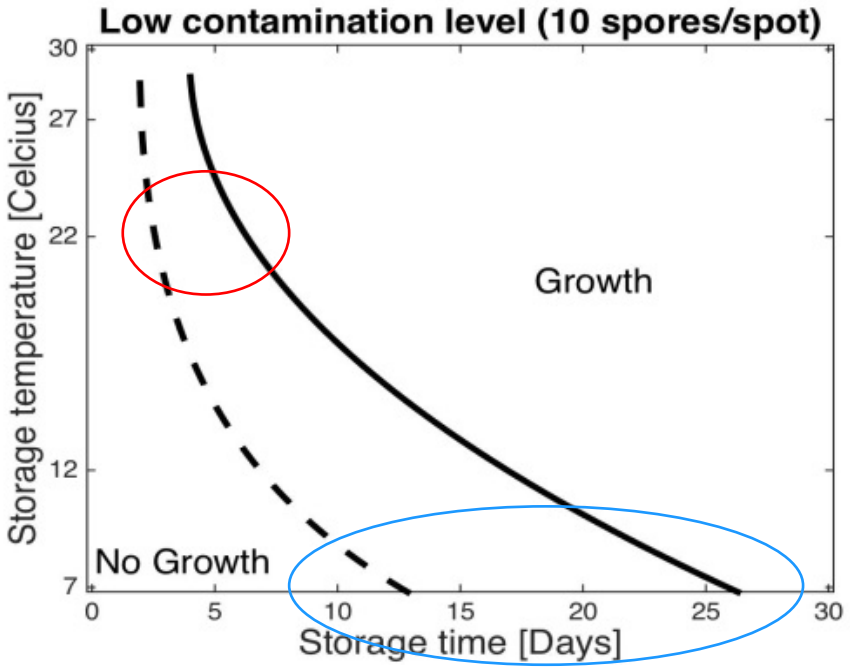
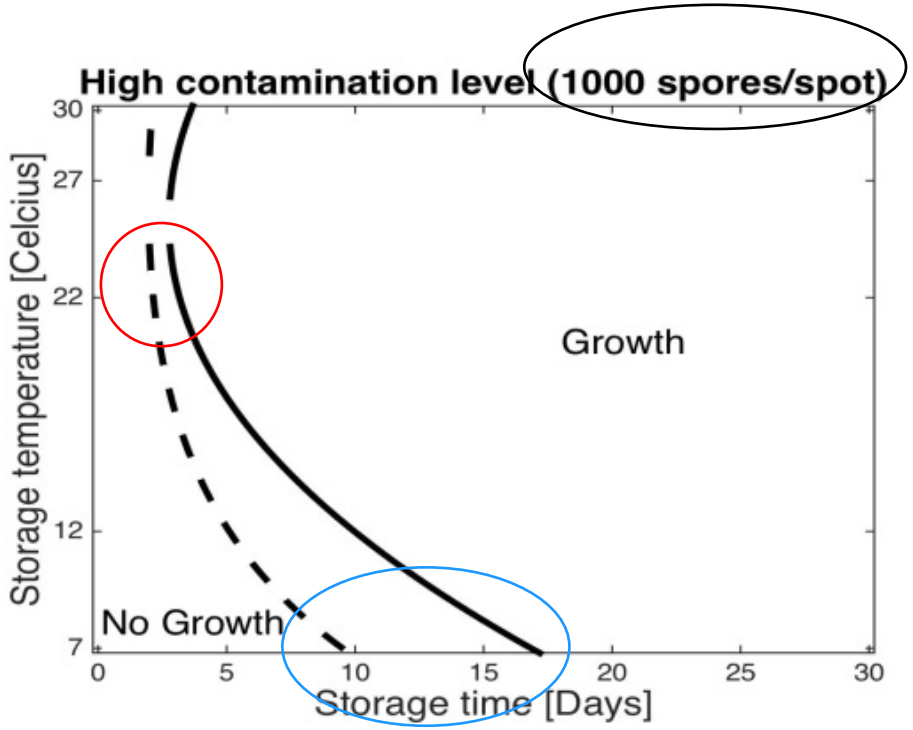
Bioprotection adds to the hurdle effects

Growth/No growth boundaries on time to first visible growth





Bold: With bioprotective culture
Dotted: Without bioprotective culture

Challenge test studies conducted at Chr. Hansen, Hørsholm lab

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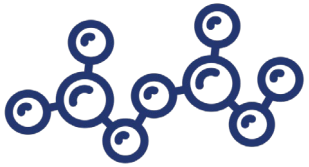
For years, the bioprotective mechanisms remained unclear

It has been proposed that the bioprotective effect is achieved by a combination of the following mechanisms:



PRODUCTION OF WEAK ORGANIC ACIDS

PRODUCTION OF OTHER NATURAL METABOLITES

COMPETITION FOR NUTRIENTS

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Development of weak organic acids during fermentation explains part of the bioprotective effect

Food cultures with protective effect are lactic acid bacteria which can produce **weak organic acids** including **lactic acid** and **acetic acid** during fermentation. Both are known to delay growth of many types of contaminants including yeasts and molds.

Production of weak organic acids

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Current Opinion in Biotechnology

ELSEVIER

Bioprotective mechanisms of lactic acid bacteria against fungal spoilage of food

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Siedler S, et. al, 2019

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Production of natural metabolites during fermentation also explains part of the bioprotective effect

Some metabolites commonly known to be produced by LAB at small amounts, such as **diacetyl, phenyllactic acid, peptides**, etc., add to the protective effects of food cultures.

Production of natural metabolites

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OXFORD FEMS JOURNALS investing in science

FEMS Yeast Research, 18, 2018, foy094

doi: 10.1093/femsyr/foy094
Advance Access Publication Date: 23 August 2018
Research Article

RESEARCH ARTICLE

Identification and characterization of a new antifungal peptide in fermented milk product containing bioprotective *Lactobacillus* cultures

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McNair LKF, et. al, 2018

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Competition for nutrients is a major bioprotective mechanism

Certain lactic acid bacteria are able to delay the growth of spoilage organisms by effectively using the nutrients that they need to grow. Our breakthrough discovery shows that in dairy products, it is particularly **the competition for manganese** which delays the growth of yeasts and molds.

Competition for nutrients

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FOOD MICROBIOLOGY

Competitive Exclusion Is a Major Bioprotective Mechanism of Lactobacilli against Fungal Spoilage in Fermented Milk Products

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Siedler, S. et al, 2020- https://aem.asm.org/content/86/7/e02312-19

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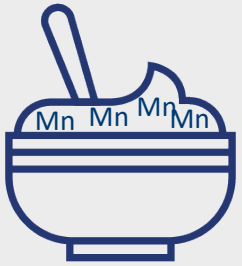
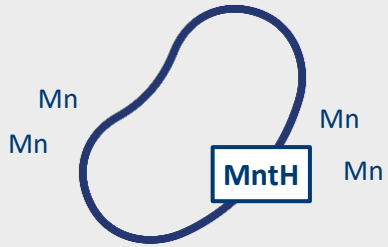
Competition for manganese is mediated by a specific transporter (MntH)



AN ESSENTIAL NUTRIENT

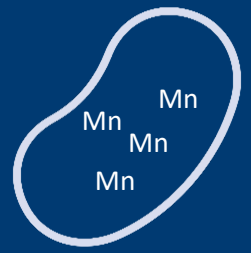
Manganese is an essential nutrient for bacteria, yeast and mold to grow.

It is available in fermented dairy products such as yogurt in very limited levels. [1,2]



A SPECIFIC TRANSPORTER

Certain LAB strains can absorb manganese through a transporter (MntH).



FREE MANGANESE SCAVENGER

Free manganese is taken up by the LAB from fermented dairy products, such as yogurt, thereby further limiting the availability of this essential nutrient used by yeasts and molds for their growth.

1 Eurofins analysis
2 https://frida.fooddata.dk/

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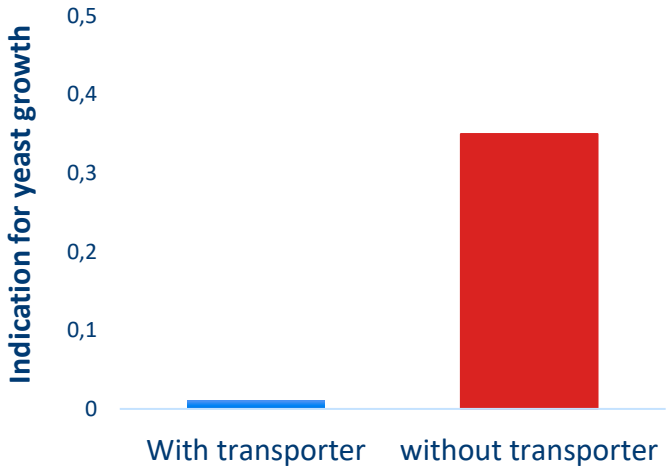
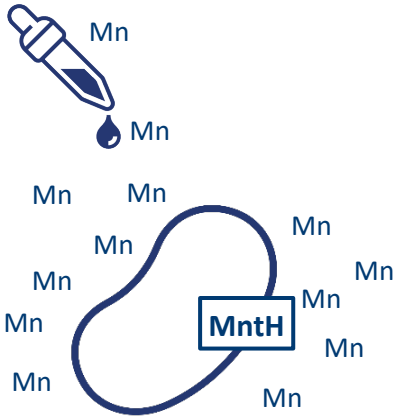
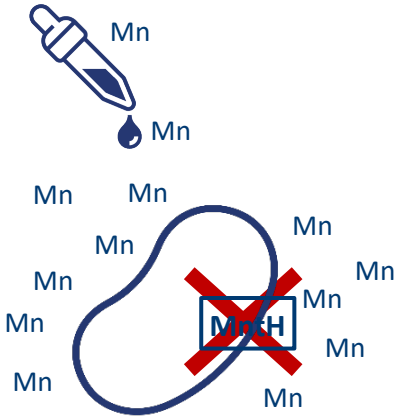
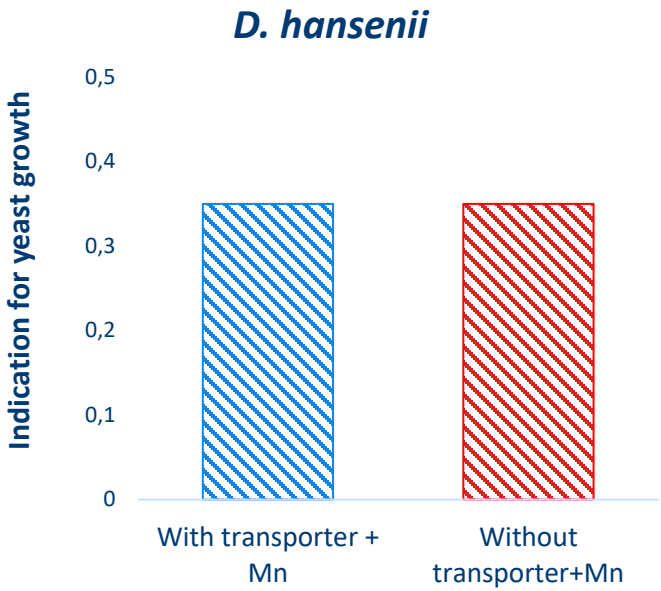
The importance of manganese transporter for bioactivity is confirmed at the gene level









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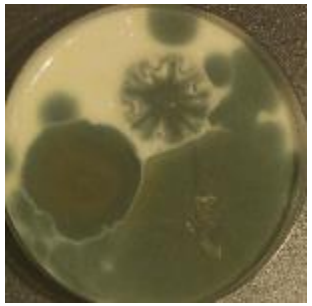
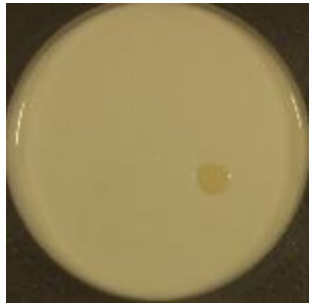
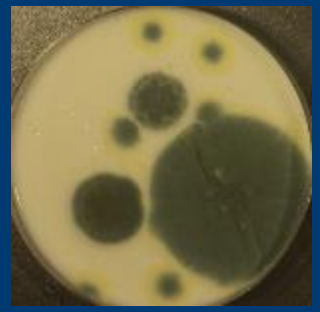
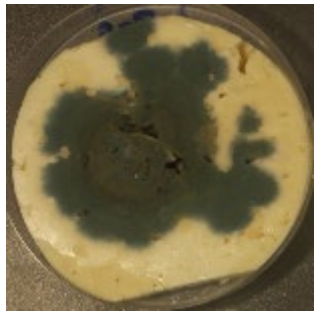
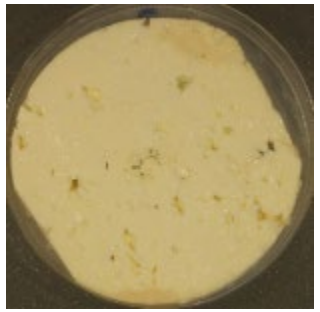
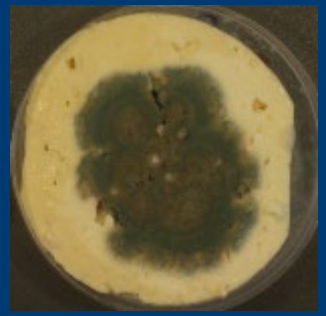
Experiments show that increasing available manganese reduces the bioprotective effect against mold

APPLICATION	REFERENCE	FOOD CULTURES WITH BIOPROTECTIVE EFFECT	
		Without manganese added	With manganese added
Yogurt			
White brined cheese			

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Competition for nutrients is a major mechanism of cultures with bioprotective effect against yeast and mold in dairy food

COMPETITION FOR NUTRIENTS

Our breakthrough discovery shows that in dairy products, it is particularly the competition for manganese which delays the growth of yeasts and molds.

PRODUCTION OF WEAK ORGANIC ACIDS

PRODUCTION OF NATURAL METABOLITES

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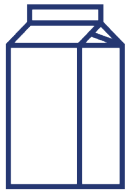
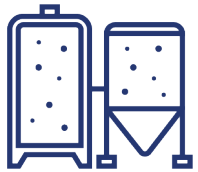
For cultures with bioprotective effect to work effectively, the following conditions need to be met



THE INITIAL LEVEL OF MN IS LOW IN THE PRODUCT

Milk (cow, goat and sheep) contains sufficiently low levels of Mn in order to be effectively depleted by food cultures with bioprotective effect



FOOD CULTURES WITH BIOPROTECTIVE EFFECT TAKE PART IN THE FERMENTATION WITH A STARTER CULTURE

Fermentation by a starter culture activates the MntH transporter of food cultures with bioprotective effect

FOOD CULTURES WITH BIOPROTECTIVE EFFECT STAY ALIVE IN THE FINAL PRODUCT

Activity of live bioprotective cells will be needed to continuously take up Mn and protect the product

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Food cultures with bioprotective effect can benefit you in five distinct ways: