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Smart design of functional fermented dairy foods

Gwénaél Jan

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AGRO
CAMPUS
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Smart design of functional fermented dairy foods



STLOpen Days
19-21 March 2019



Gwénaél JAN - Microbio



Food quality & safety



Develop safe, healthy, sustainable and hedonic fermented foods



Food spoilage



Reduce health risks and food losses and waste



The cheese matrix as a delivery vehicle for probiotics bacteria

Animal health



Offer alternatives to antibiotic treatments (probiotics)



Health & wellbeing



Develop functional and designer food against modern lifestyle diseases

Driving functionality

→ through matrices



→ this talk

→ through processes



→ earlier

The concept of « 2-in-1 » bacteria

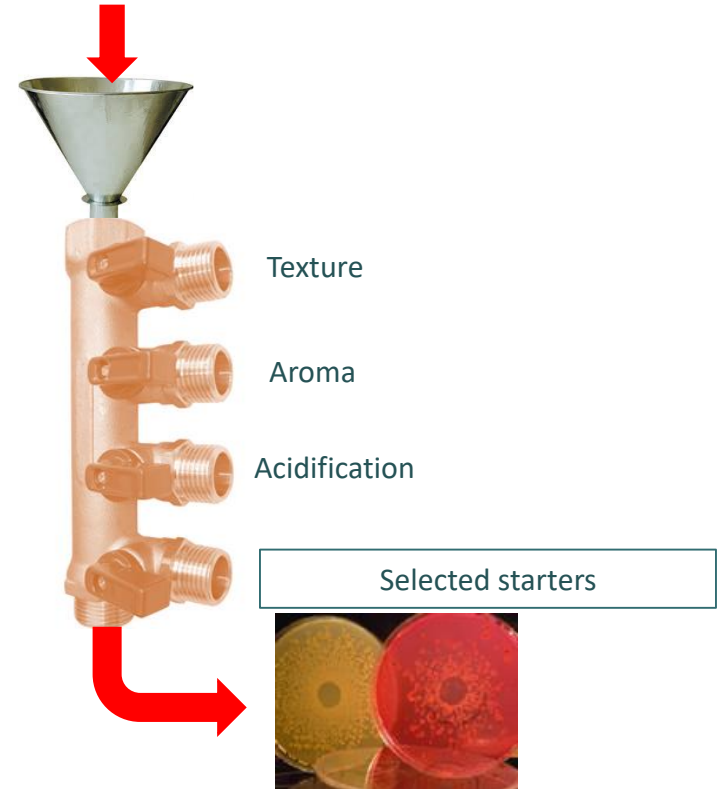


And now we select the bacteria

The technological pathway use to select the bacteria



Historically without added starter!!!!



Texture

Aroma

Acidification

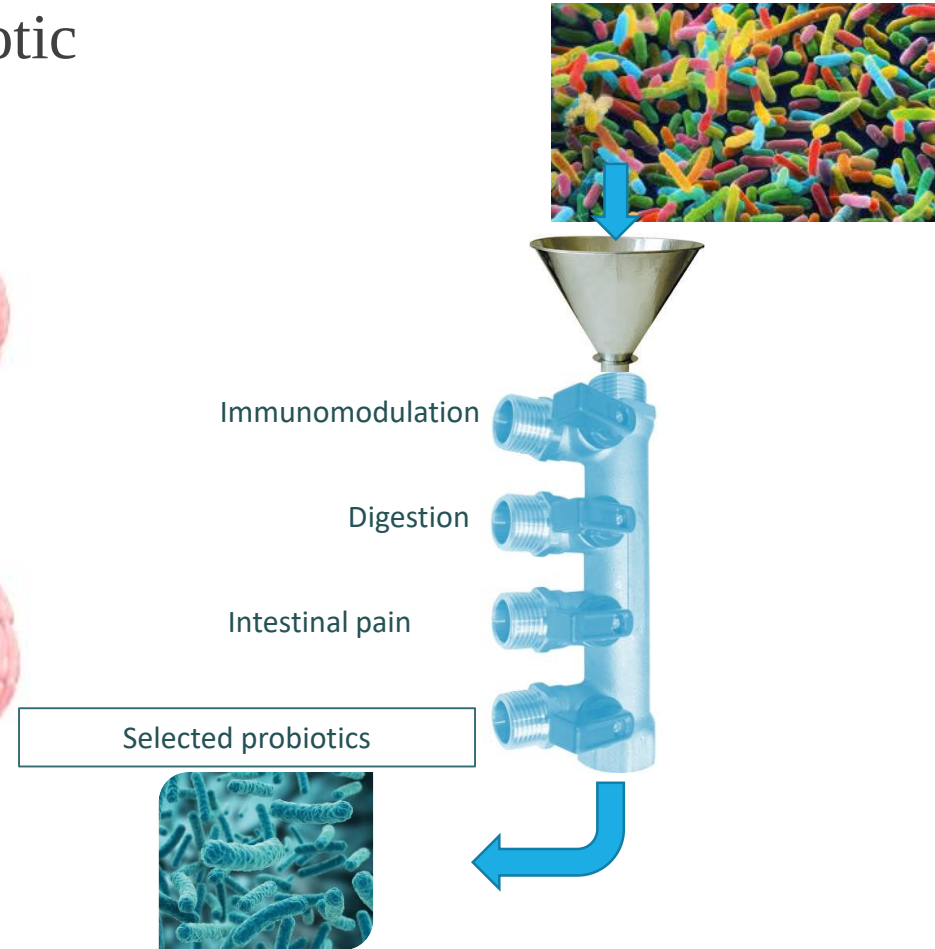
Selected starters



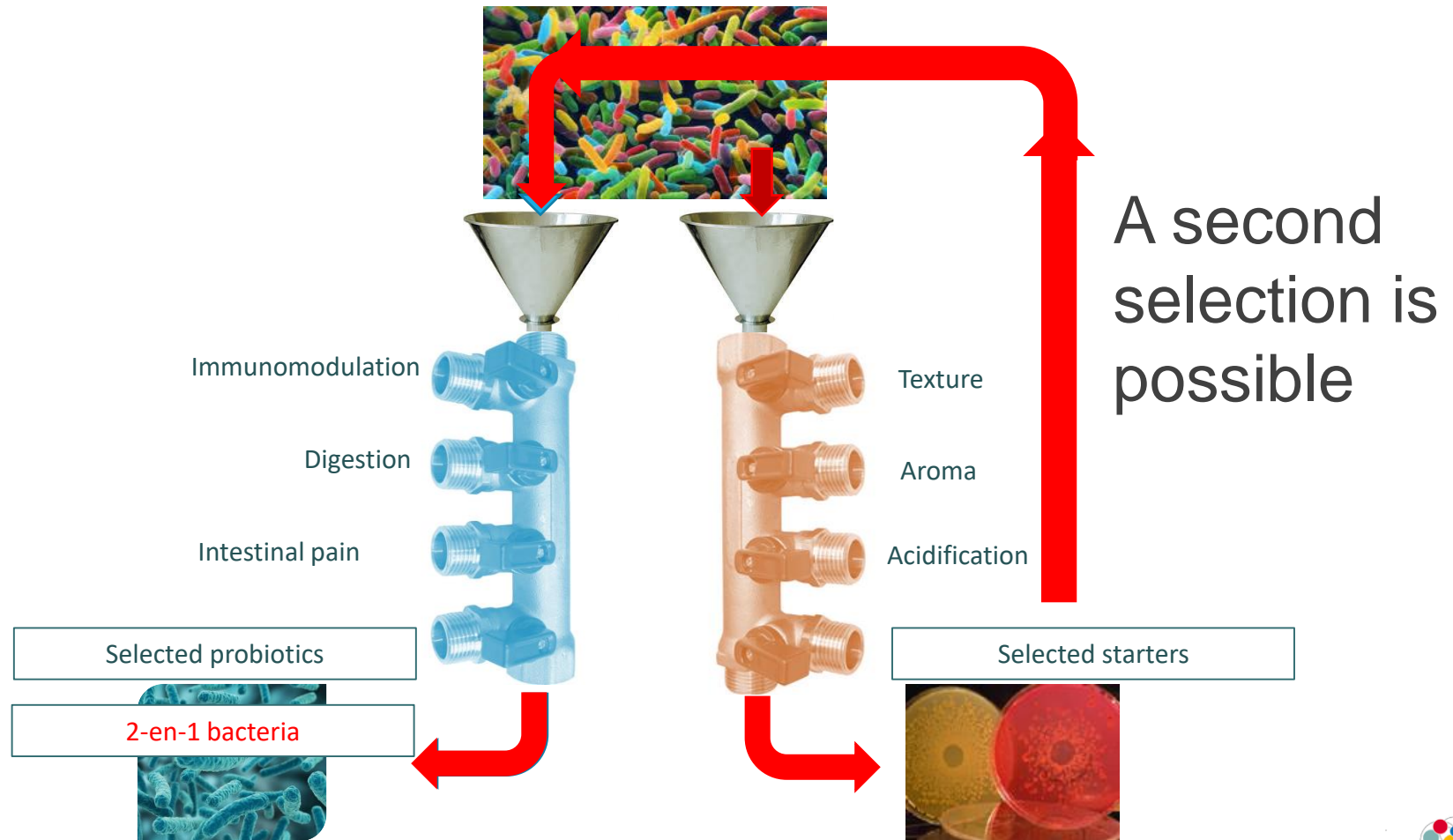
The concept of « 2-in-1 » bacteria

Other bacteria are selected for probiotic properties

IBS, IBD, atopy, intolerance ...



The concept of « 2-in-1 » bacteria



« 2-in-1 » propionibacteria

Anti-inflammatory properties



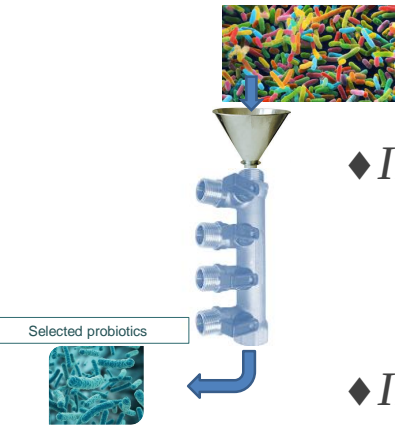
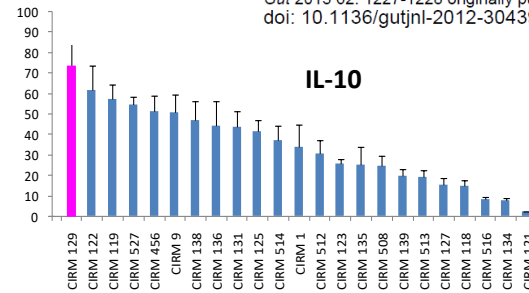
Propionibacterium freudenreichii



Tracking the microbiome functionality: focus on Propionibacterium species

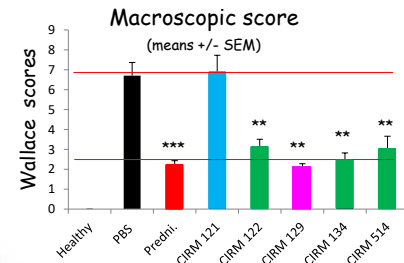
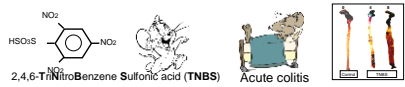
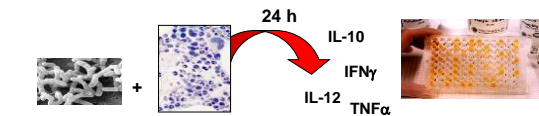
Benoit Foligné, Jérôme Breton, Denis Mater, et al.

Gut 2013 62: 1227-1228 originally published online February 6, 2013
doi: 10.1136/gutjnl-2012-304393



◆ *In vitro*

◆ *In vivo*



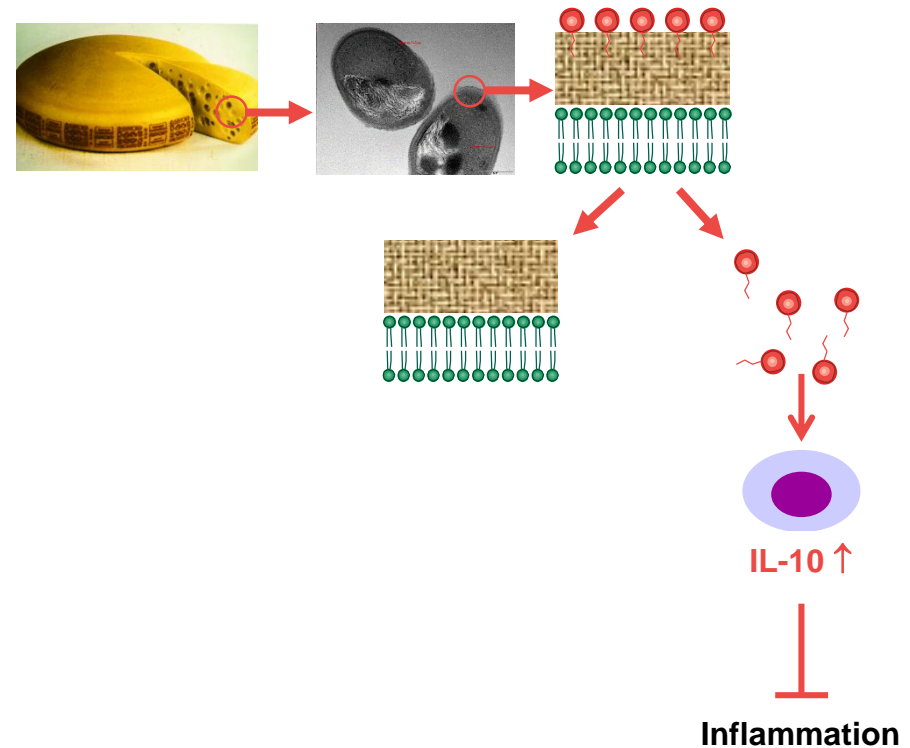
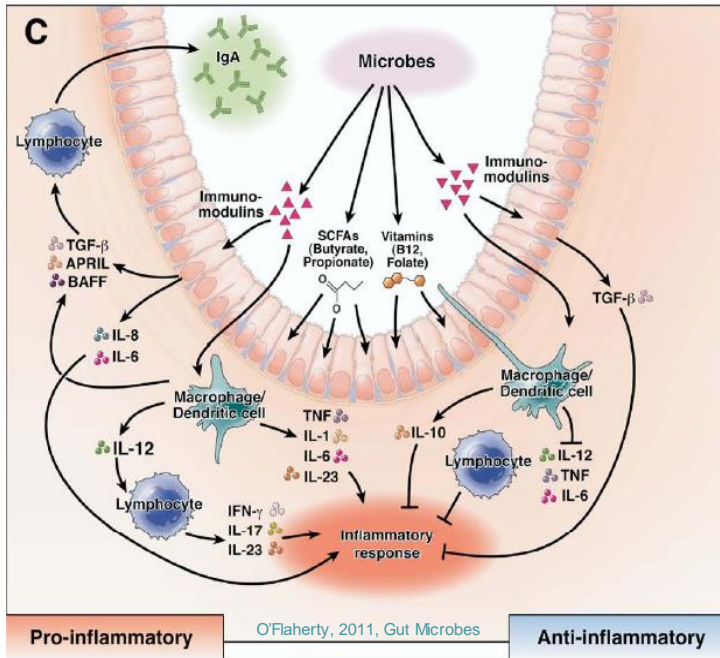
APPLIED AND ENVIRONMENTAL MICROBIOLOGY, Dec. 2010, p. 8259-8264
0099-2240/10/\$12.00 doi:10.1128/AEM.01976-10
Copyright © 2010, American Society for Microbiology. All Rights Reserved. Vol. 76, No. 24

Promising Immunomodulatory Effects of Selected Strains of Dairy Propionibacteria as Evidenced *In Vitro* and *In Vivo*

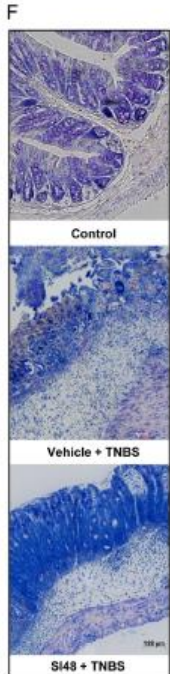
Benoit Foligné,^{1,2,3,4} Stéphanie-Marie Deutsch,^{5,6} Jérôme Breton,^{1,2,3,4} Fabien J. Cousin,^{5,6,7} Joëlle Dewulf,^{1,2,3,4} Michel Samson,⁸ Bruno Pot,^{1,2,3,4} and Gwénaél Jan^{5,6*}



A key role of propionibacteria surface proteins



Other « 2-in-1 » bacteria



APPLIED AND ENVIRONMENTAL MICROBIOLOGY, Dec. 2010, p. 8259-8264
 0099-2240/10/\$12.00 doi:10.1128/AEM.01976-10
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Vol. 76, No. 24

Promising Immunomodulatory Effects of Selected Strains of Dairy Propionibacteria as Evidenced *In Vitro* and *In Vivo*[†]

Benoît Foligné,^{1,2,3,4} Stéphanie-Marie Deutsch,^{5,6} Jérôme Breton,^{1,2,3,4} Fabien J. Cousin,^{5,6,7}
 Joëlle Dewulf,^{1,2,3,4} Michel Samsø



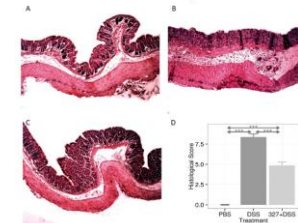
Let's make probiotic cheese!!!

OPEN ACCESS Freely available online



Local and Systemic Immune Mechanisms Underlying the Anti-Colitis Effects of the Dairy Bacterium *Lactobacillus delbrueckii*

Clarissa Santos Rocha^{1,3,4}, Ana Cristina Gomes-Santos², Thais Garcias Moreira², Marcela de Azevedo¹,
 Tessalia Diniz Luerce¹, Mahendra Mariadassou⁵, Ana Paula Longaray Delamare⁶, Philippe Langella^{3,4},
 Emmanuelle Maguin^{3,4}, Vasco Azevedo¹, Ana Maria Caetano de Faria², Anderson Miyoshi^{1*},
 Maarten van de Guchte^{3,4,*}



A reverse-engineered 2-strains cheese



Microfiltr. Milk

↓
Powder 100 g/L

↓
Cream 150 g/L

↓
Sterilisation

↓
Culture *P. freudenreichii*
30°C, 72 h

↓
Pre-cheese

UHT Milk

↓
Culture *L. delbrueckii*
42°C, 4 h

↓
Fermented Milk



↓
Clotting, stirring, cooking, moulding,
pressing, wrapping, ripening



Dairy Platform



Mol. Nutr. Food Res. 2016, 60, 935–948

Molecular Nutrition
Food Research

935

RESEARCH ARTICLE

**Combining selected immunomodulatory
Propionibacterium freudenreichii and *Lactobacillus delbrueckii* strains: Reverse engineering development of an anti-inflammatory cheese**

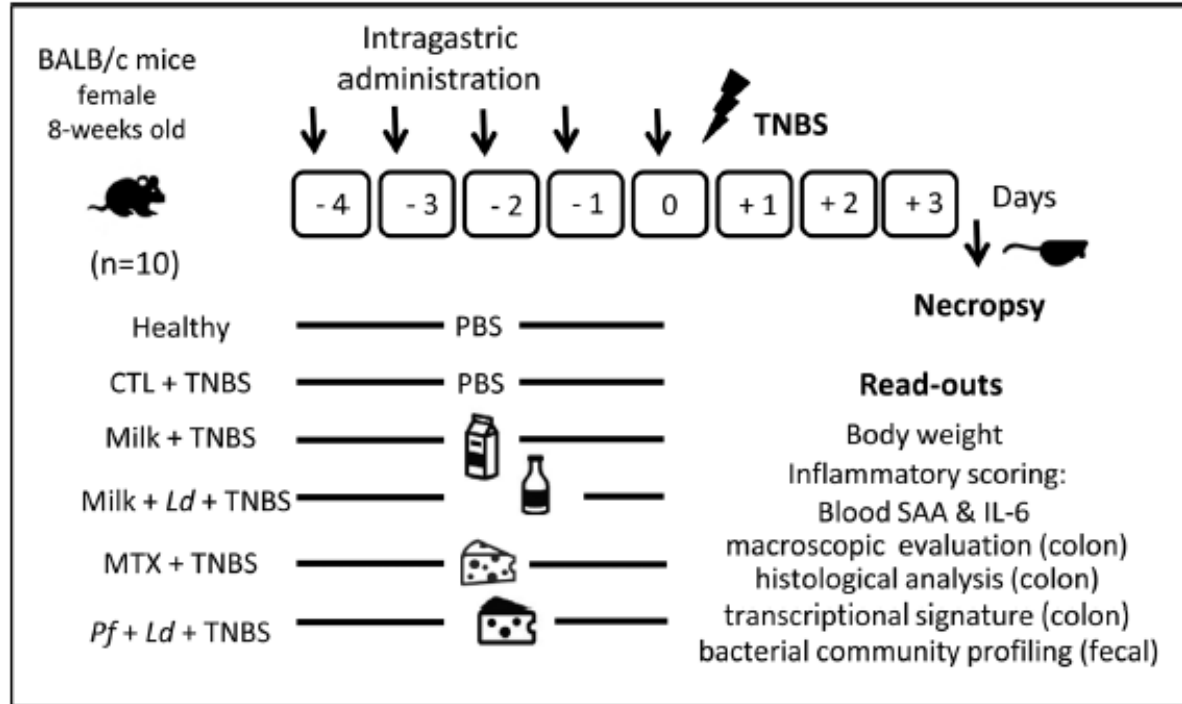
Coline Plé¹, Jérôme Breton¹, Romain Richoux², Marine Nurdin², Stéphanie-Marie Deutsch^{3,4},
Hélène Falentin^{3,4}, Christophe Hervé⁵, Victoria Chuat^{3,4,6}, Riwanon Lemée⁵,
m^{3,4}, Maarten Van de Guchte^{7,8} and Benoit Foligné¹



Starter Surface
against Inflammation of the Gut

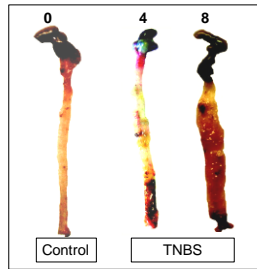


A reverse-engineered 2-strains cheese challenged *in vivo*

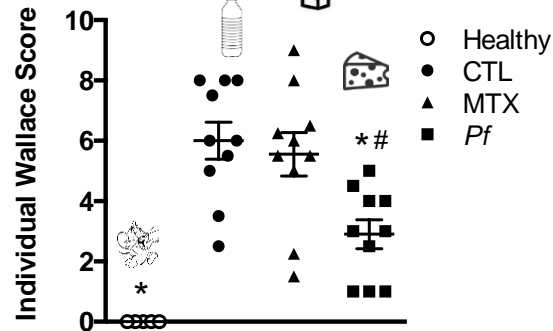
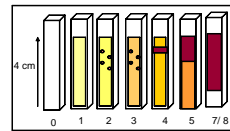


A reverse-engineered 2-strains cheese protects from colitis

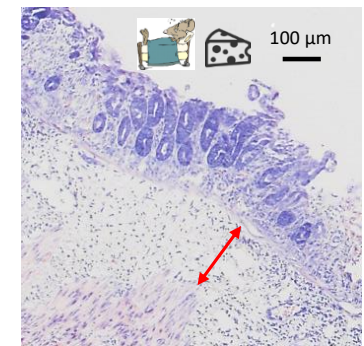
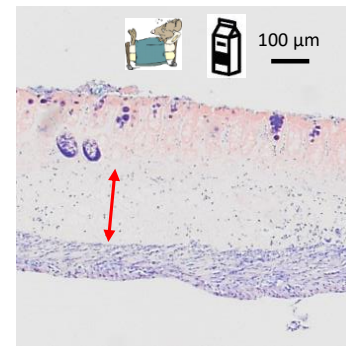
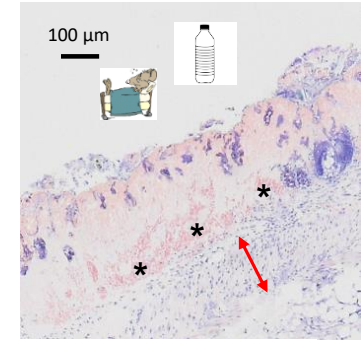
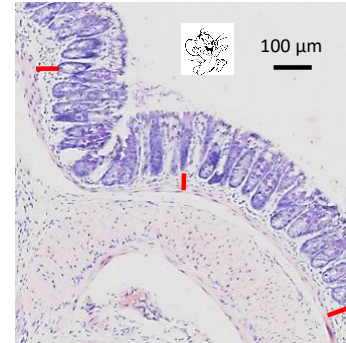
Macroscopic level



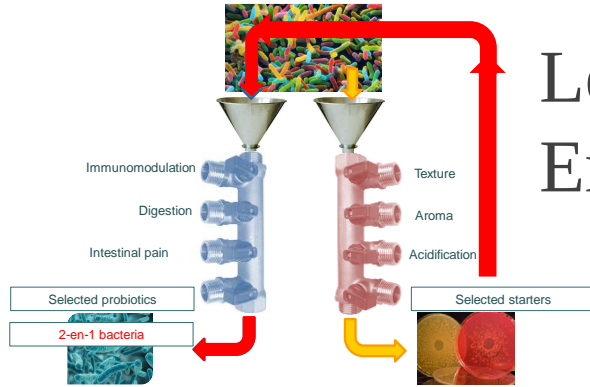
Macroscopic score (Wallace)



Microscopic level

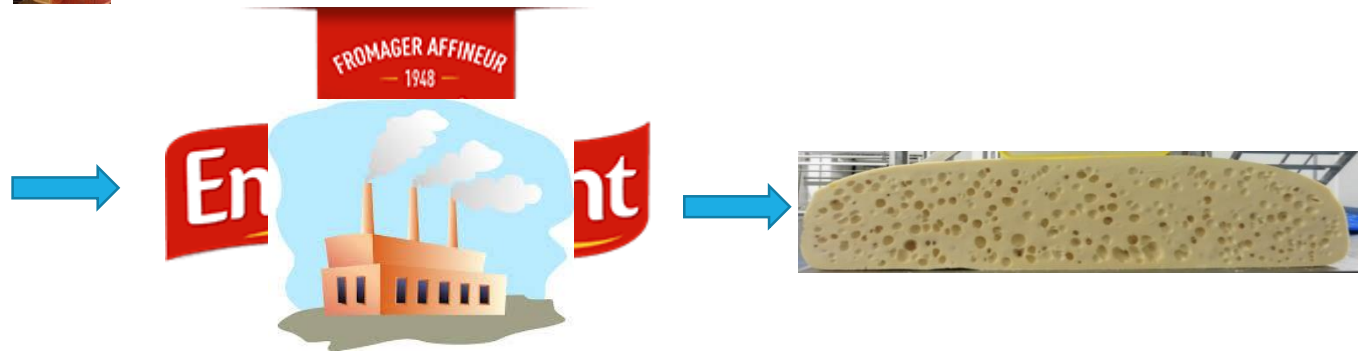


But it is still a lab cheese!

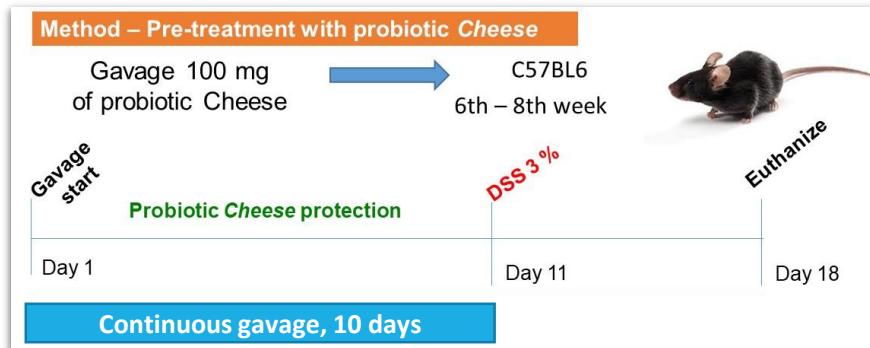


Let's make a real
Emmental cheese!

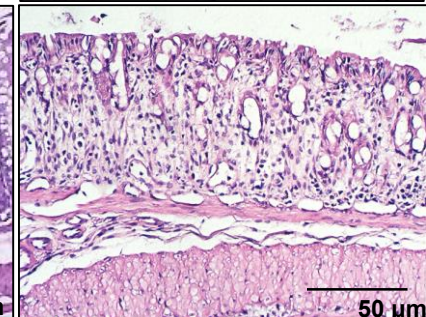
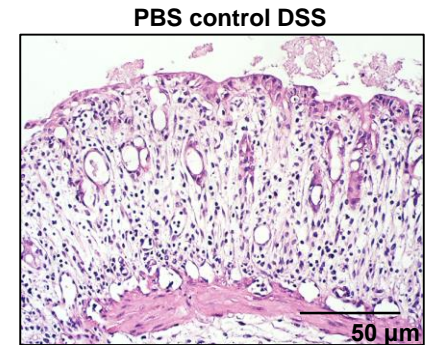
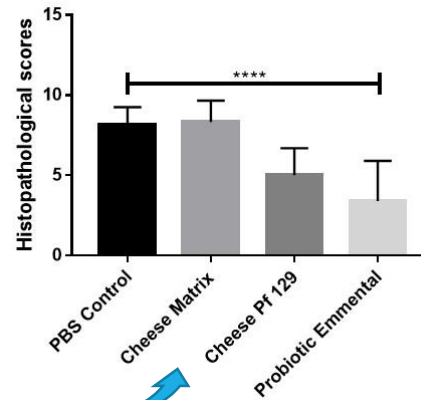
Propionibacterium freudenreichii
Streptococcus thermophilus
Lactobacillus delbrueckii



This Emmental cheese protects from colitis



Probiotic Emmental x Colitis



Noninflamed control

Probiotic Emmental

Another example of application: fighting mucositis

GI inflammatory diseases

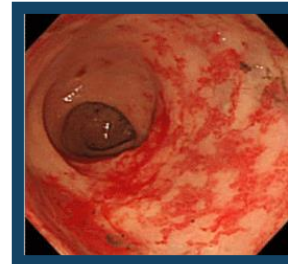
IBD

- GIT Chronic inflammation

Ulcerative
Colitis



Mucositis



GI Mucositis



Oral mucositis

5-Fluoracil (5-FU)

- Head, neck and colon cancer.

(Chang *et al.*, 2012; Falvey *et al.*, 2015)



Another example of application: fighting mucositis

→ NO CURE AVAILABLE

IBD available treatment

Mucositis available treatment

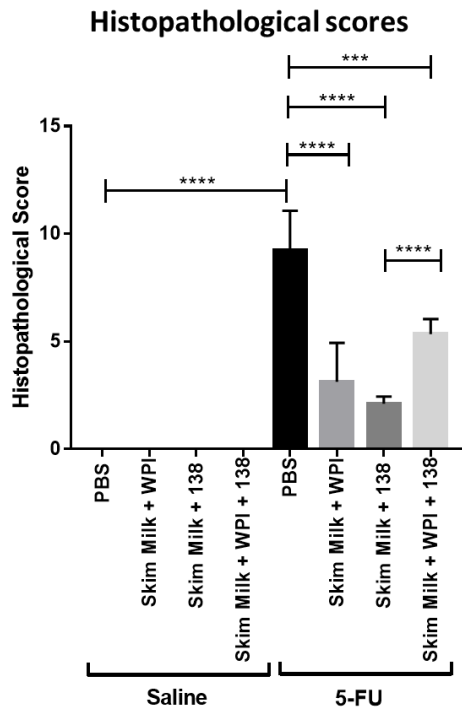
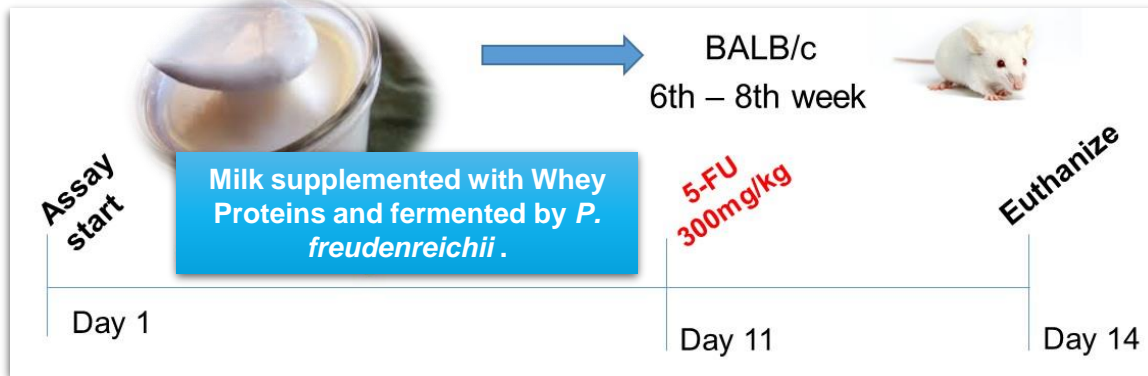
- Treatment for **mucositis** and **IBD** are limited;
- Development of **new therapies** is **necessary**.

Strong side effects!!!

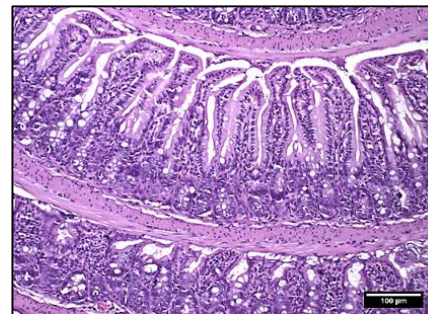
Temporary benefit!!!



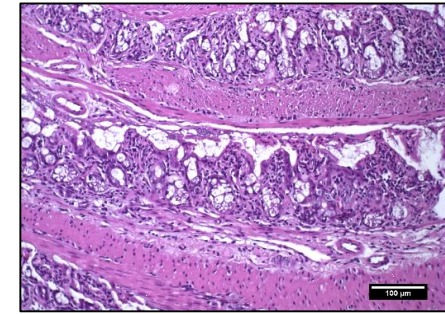
Fermented milk protects from mucositis



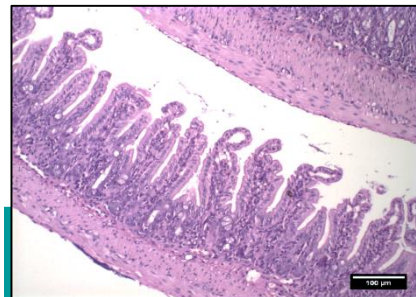
Representative images from mucosal histopathology (H&E)



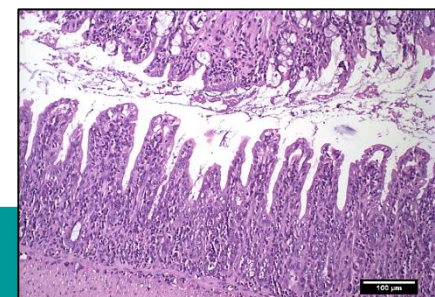
Healthy Ileum



PBS + 5-FU

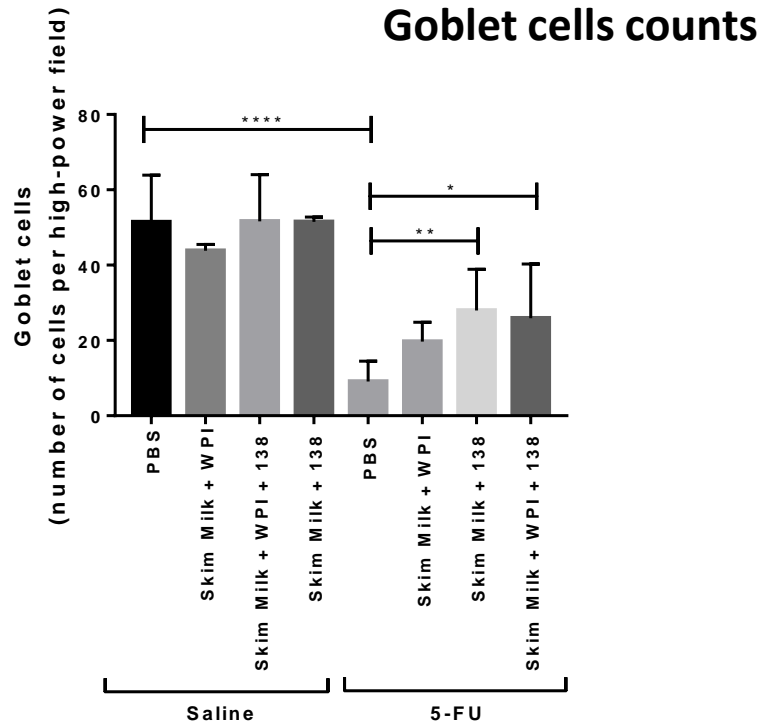


LDF + 138 + 5-FU

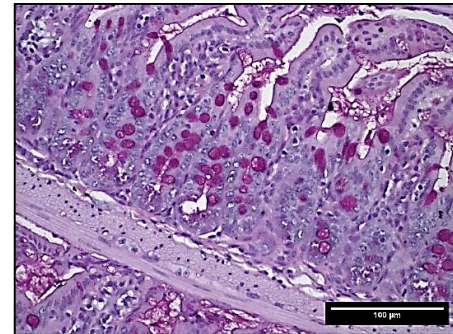


LDFWPI + 138 + 5-FU

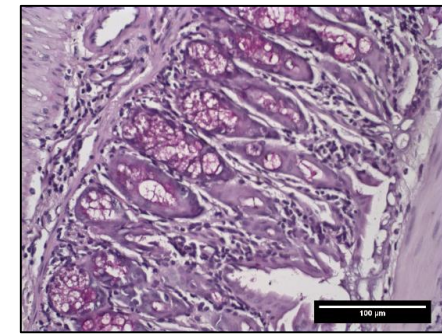
Fermented milk preserves mucus



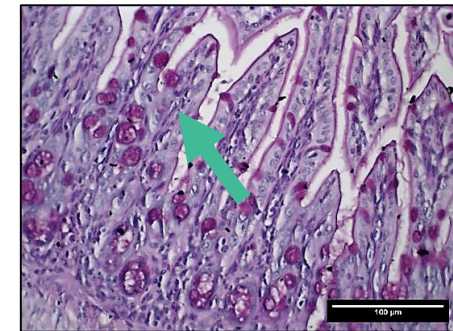
Representative images of stained goblet cells (PAS)



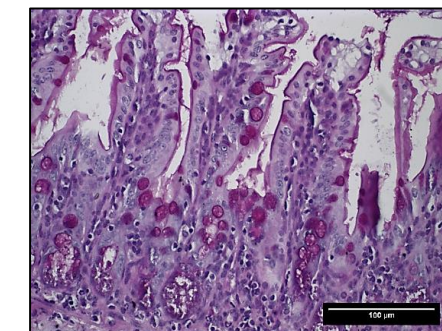
Healthy Ileum



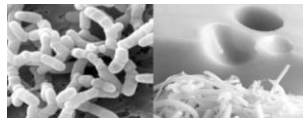
PBS + 5FU



LDF + 138 + 5FU



LDFWPI + 138 + 5FU



Conclusion:

- ✓ Fermented foods: a source of immunomodulatory bacteria
- ✓ Molecules and strains involved are being identified

Perspectives :

- ✓ Preclinical and clinical studies with fermented products
- ✓ Fermented food for specific populations



Benoit Foligné



Vasco Azevedo



Houem Rabah

Song Huang

Fillipe Rosa do Carmo



Thank you
for your
attention

Don't ask
tough questions

**THANK YOU FOR
YOUR ATTENTION**



UNION EUROPÉENNE
UNIANIEZH EUROPA
L'Europe s'engage
en Bretagne



STLOpen Days
19-21 March 2019

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