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Combining selected immunomodulatory strains to develop an anti-inflammatory cheese

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Combining selected immunomodulatory strains to develop an anti-inflammatory cheese

Gwénaél JAN^{1,2}

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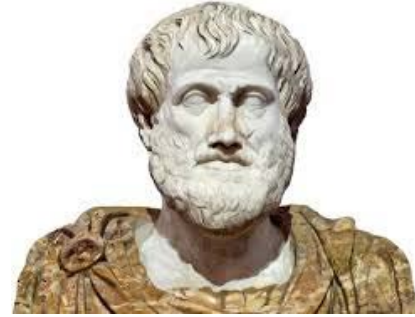
²Agrocampus Ouest, UMR 1253 Science et Technologie du Lait et de l'Œuf, Rennes





Cheese, an old story ...

Aristotle (384 BC –322 BC)



Kykeon (Gr. κυκεών, from κυκάω, "to stir, to mix"), an ancient greek made with **wine** and grated **cheese**.

A **magic** medicinal beverage



Pliny the Elder (born Gaius Plinius Secundus, AD 23–79)

« Natural History »

«De diversitate caseorum»



Describes a ewe milk cheese from Babales (Lozère, France)

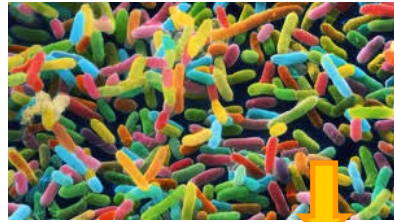
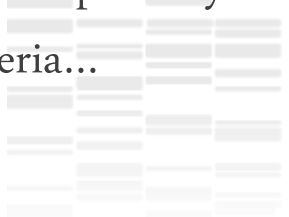


And a cow milk cheese from Arverni (Auvergnés, France)

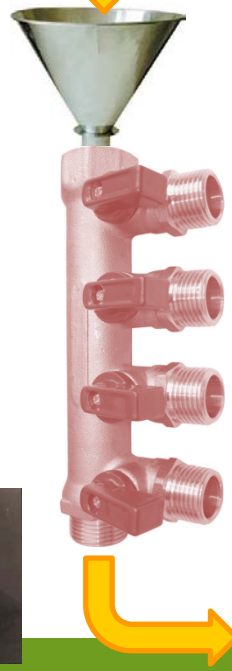
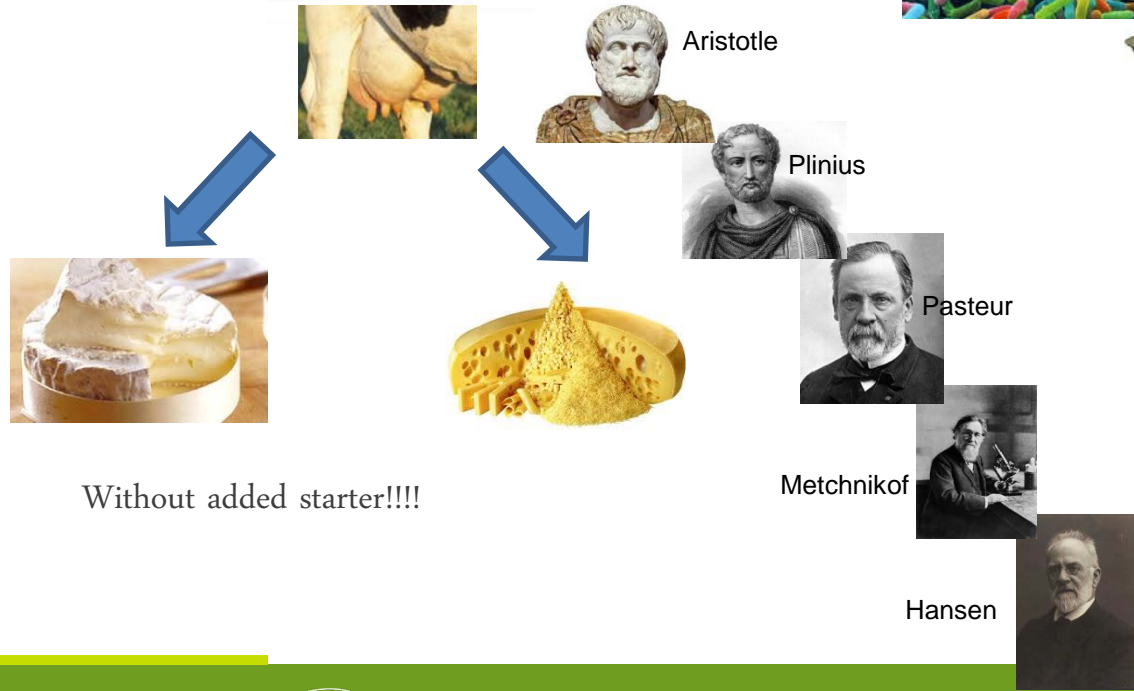


All these cheeses without added starter !!!!

The technological pathway use to select the bacteria...



...but today, we select the bacteria



- Texture
- Aroma
- Acidification

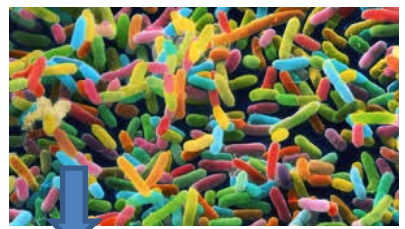
Selected starters



Other bacteria are selected for probiotic properties



IBS, IBD, atopie, intolérance ...



Immunomodulation

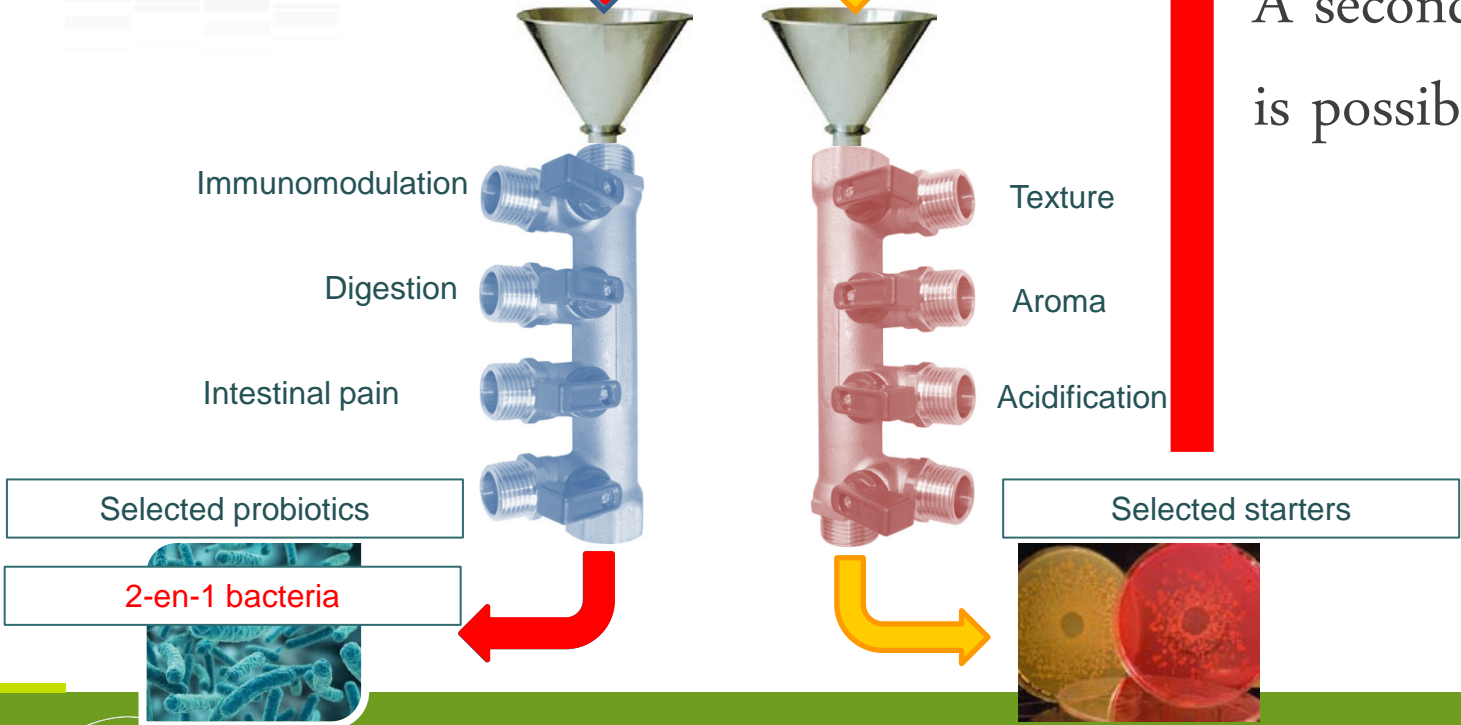
Digestion

Intestinal pain

Selected probiotics

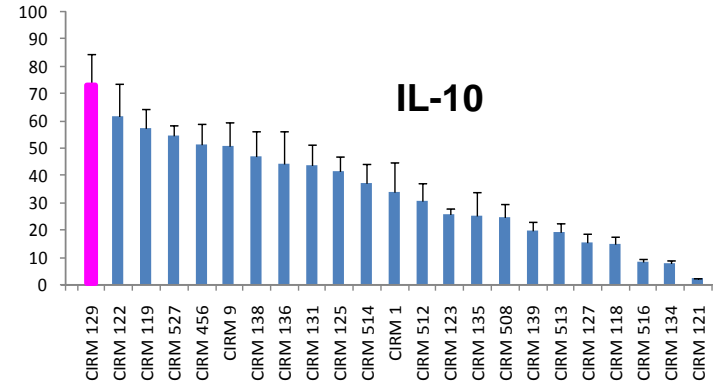
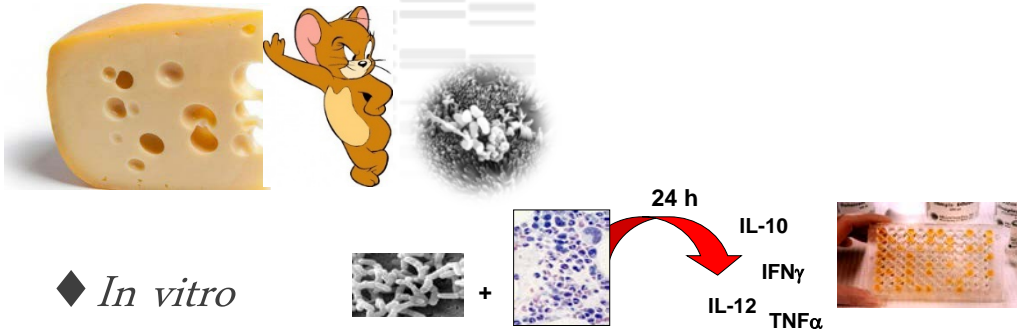


Selected bacteria

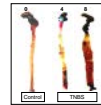
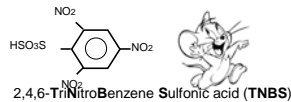


A second selection is possible

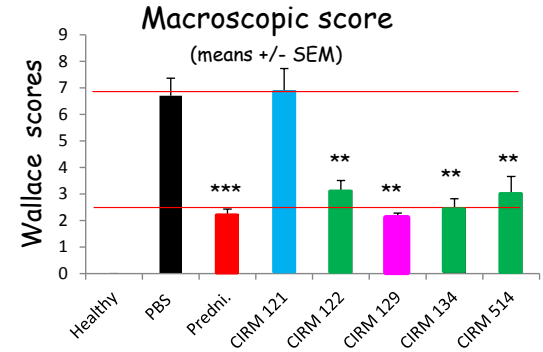
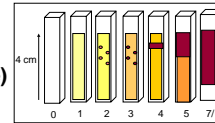
Dairy propionibacteria : immunomodulatory?



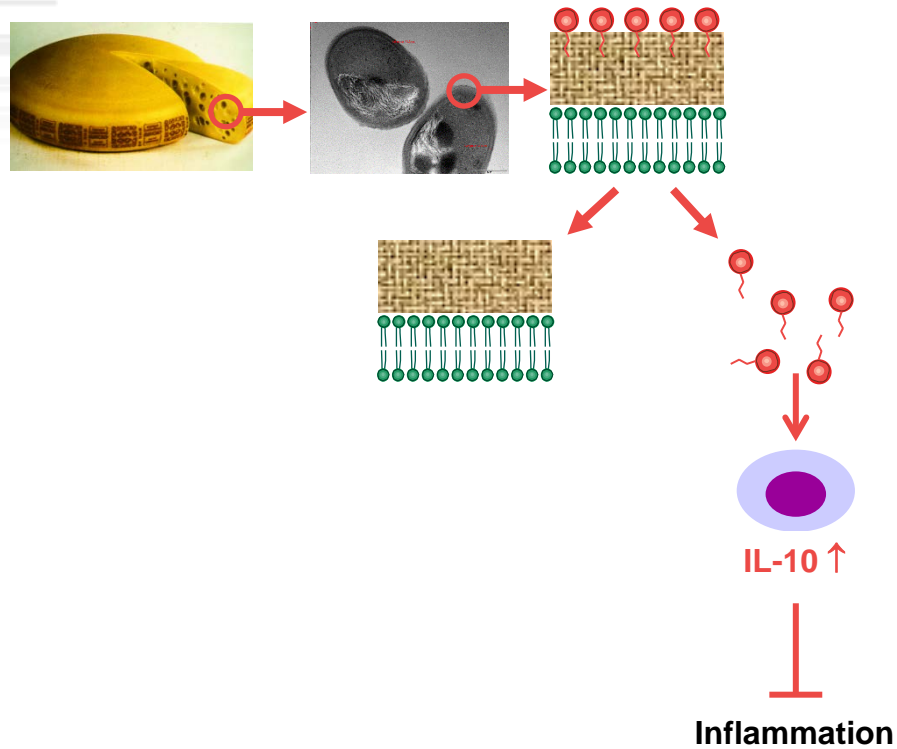
◆ *In vivo*



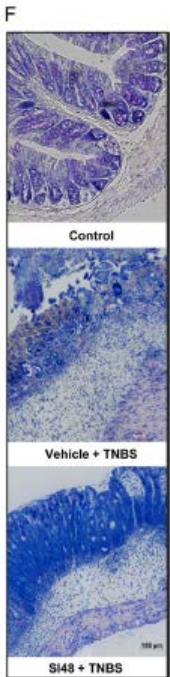
Macroscopic score (Wallace)



Mechanisms investigated



Examples of selected 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 Samson,⁸ Bruno Pot,^{1,2,3,4} and Gwénaél Jan^{5,6*}

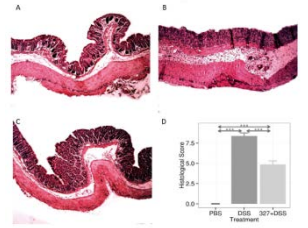


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Local and Systemic Immune Mechanisms Underlying the Anti-Colitis Effects of the Dairy Bacterium *Lactobacillus delbrueckii*

Clarissa Santos Rocha^{1,3,4}, Ana Cristina Gomes-Santos², Thais Garcia 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 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



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

DOI 10.1002/mnfr.201500580

935

RESEARCH ARTICLE

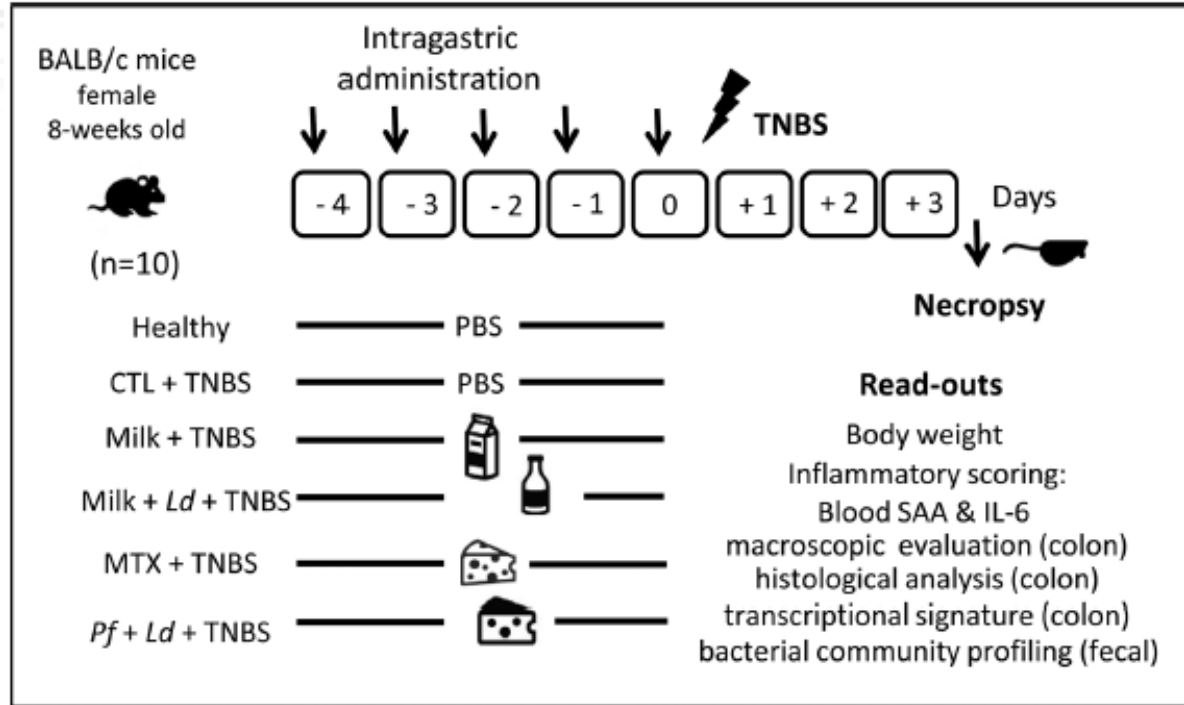


Combining selected immunomodulatory *Propionibacterium freudenreichii* and *Lactobacillus delbrueckii* strains: Reverse engineering development of an anti-inflammatory cheese

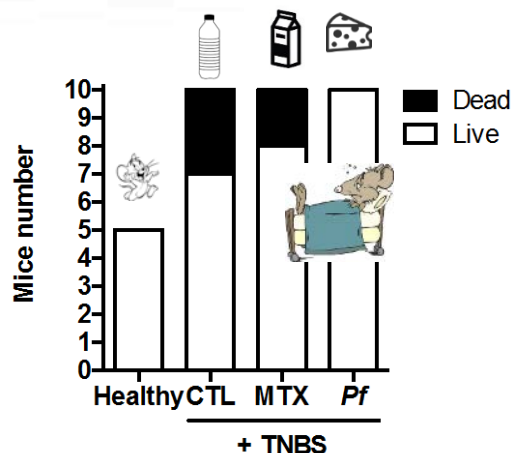
Coline Plé¹, Jérôme Breton¹, Romain Richoux², Marine Nurdin², Stéphanie-Marie Deutsch^{3,4},
 Hélène Falentin^{3,4}, Christophe Hervé⁵, Victoria Chuat^{3,4,6}, Riwanon Lemée⁵,
 Emmanuelle Maguin^{7,8}, Gwénaél Jan^{3,4}, Maarten Van de Guchte^{7,8} and Benoit Foligné¹



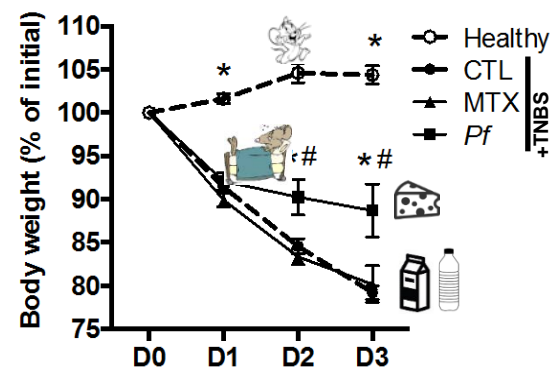
Experimental design of the animal trial



Cheese protects at the organism level



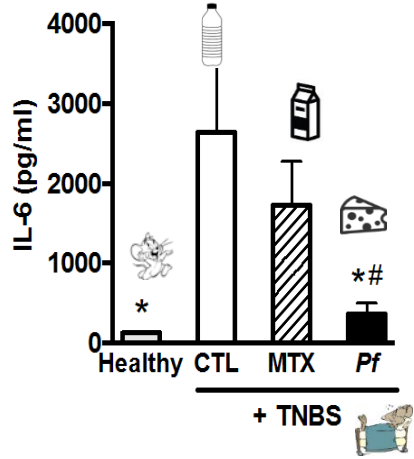
Survival



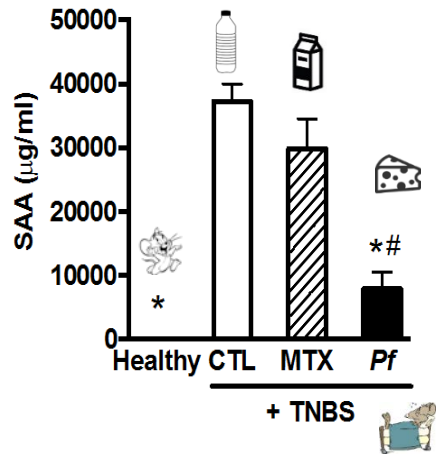
Body weight

Cheese protects at the systemic level

Blood inflammation markers

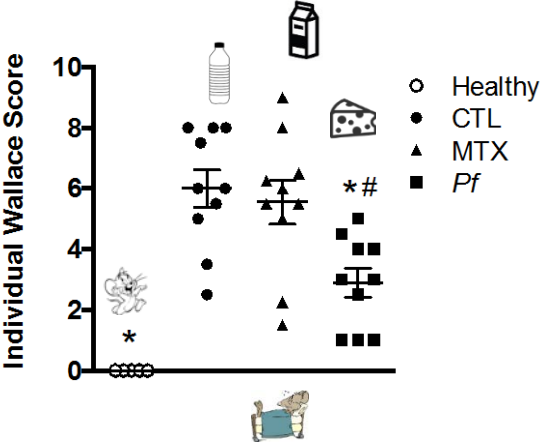
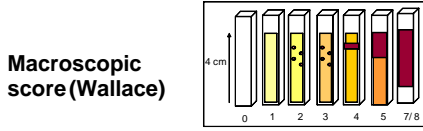
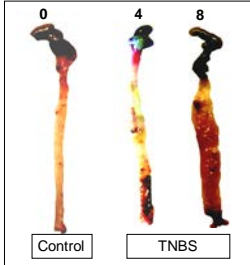
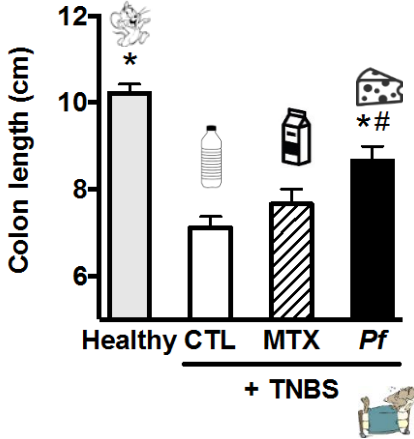


Interleukin 6

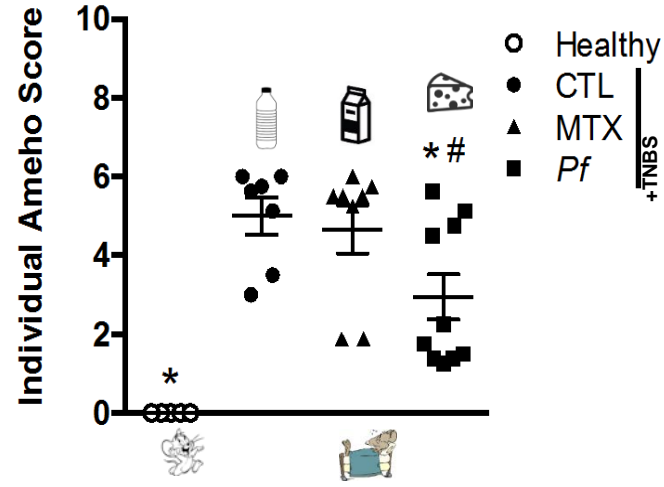
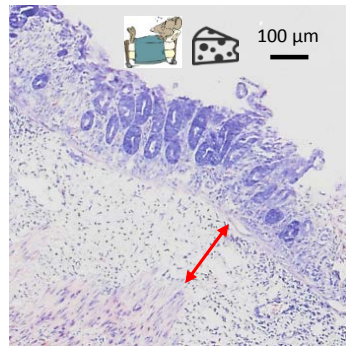
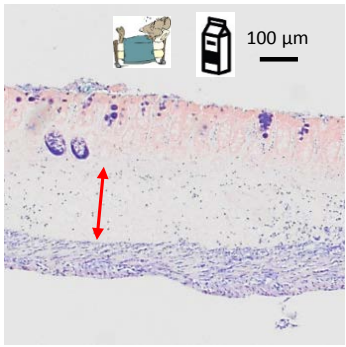
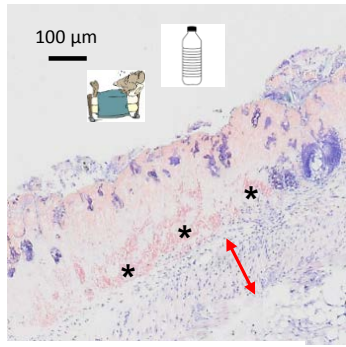
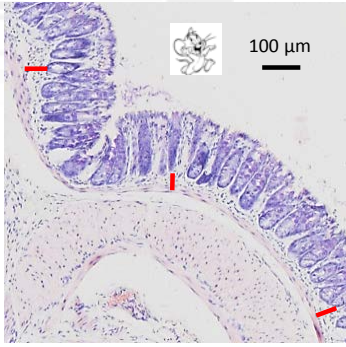


Serum Amyloid A

Cheese protects at organ level

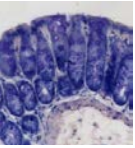
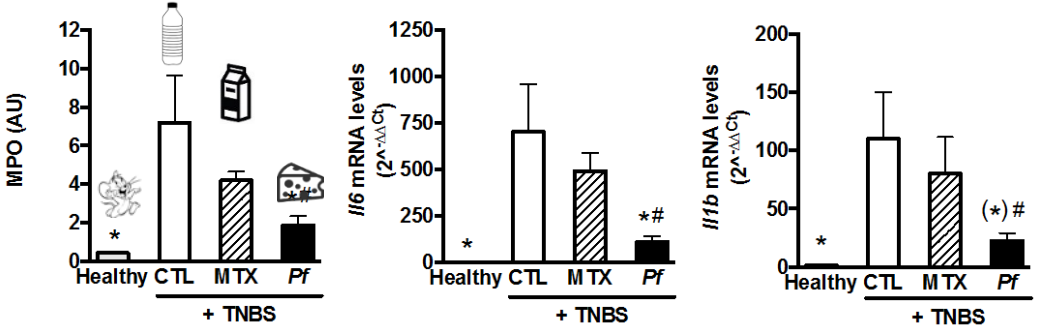


Cheese protects at the tissue level

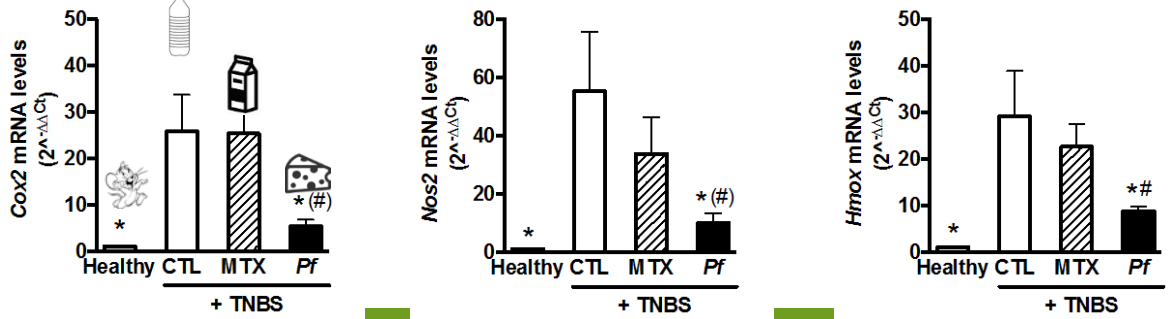


Cheese protects at the tissue level

Colonic inflammatory markers



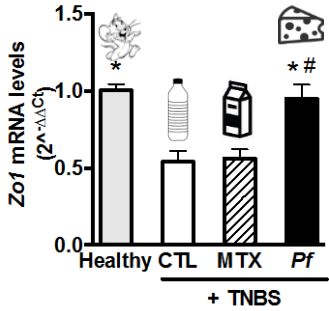
Colonic oxidative stress markers



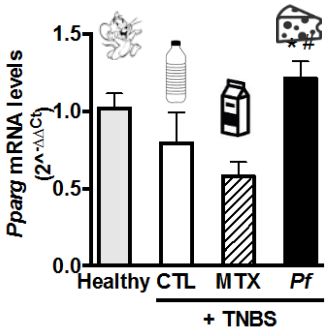
* p<0.05: vs CTL
p<0.05: vs MTX

Cheese protects at the cell level

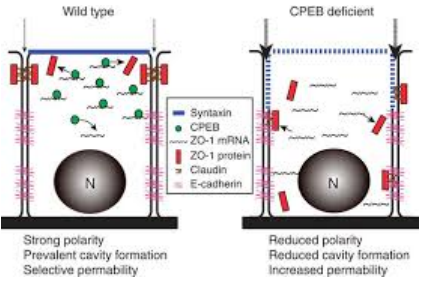
Colonic epithelial cell markers



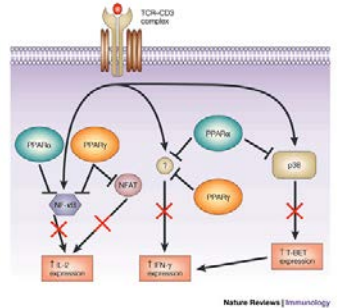
* p<0.05: vs CTL
p<0.05: vs MTX



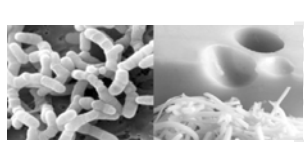
Nagaoka, Nature Communications, 2012



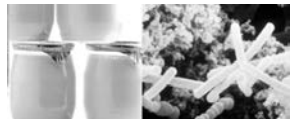
The zona occludens proteins (ZO-1, ZO-2 and ZO-3) : tight junction proteins that function as cross-linkers



Peroxisome proliferator-activated receptors (PPARs) regulate T-cell cytokine production.



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

AGRO
CAMPUS
OUEST



Fermented foods : 30% of our diet

A major source of bacteria : 10^5 to 10^9 per gram

A huge variety of bacteria



Thank
you for
your
attention

Don't ask
tough
questions



ID2Santé
Innovation and Development of the Health Sector in BRETAGNE



L'Europe s'engage
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Agence Nationale de la Recherche
ANR

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