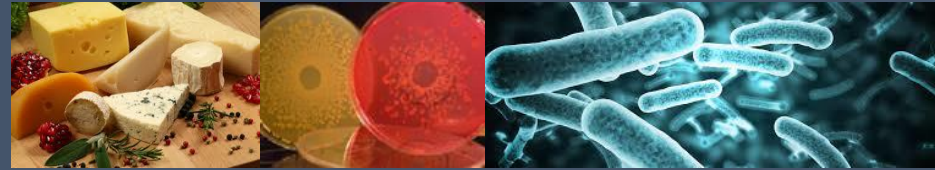




Les propriétés anti-inflammatoires de la bactérie probiotique *Propionibacterium freudenreichii* révélées de l'*in vitro* à l'*in vivo* grâce au fromage



Gwénaél JAN

UMR 1253 STLO

INRA Agrocampus Ouest, Rennes, France





L'alimentation durable, en quelques mots, c'est...



Impact réduit sur l'environnement



Travail et rémunération corrects



Aliments bons, sûrs et sains

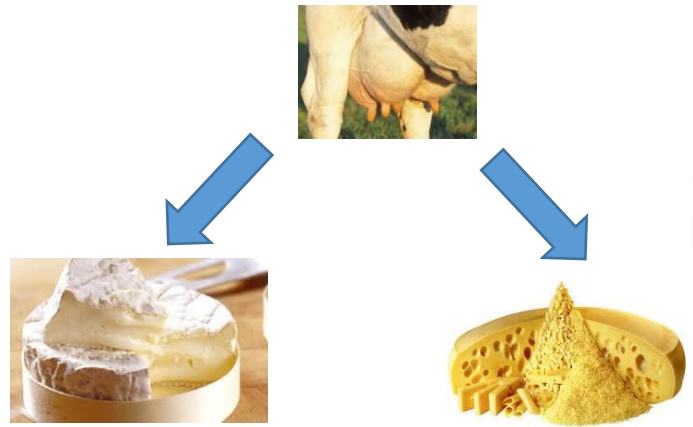


Rôle des ferments

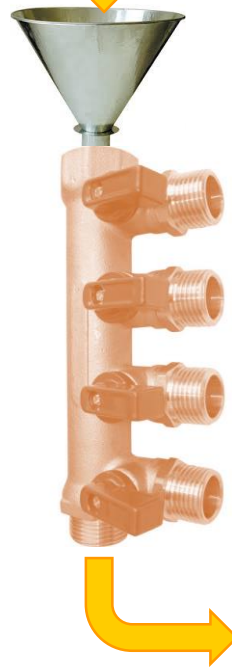
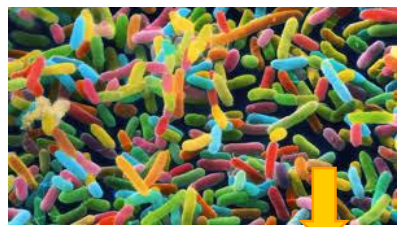


Rôle des ferments

Les ferments diffèrent ...



...et sont sélectionnés pour cela!



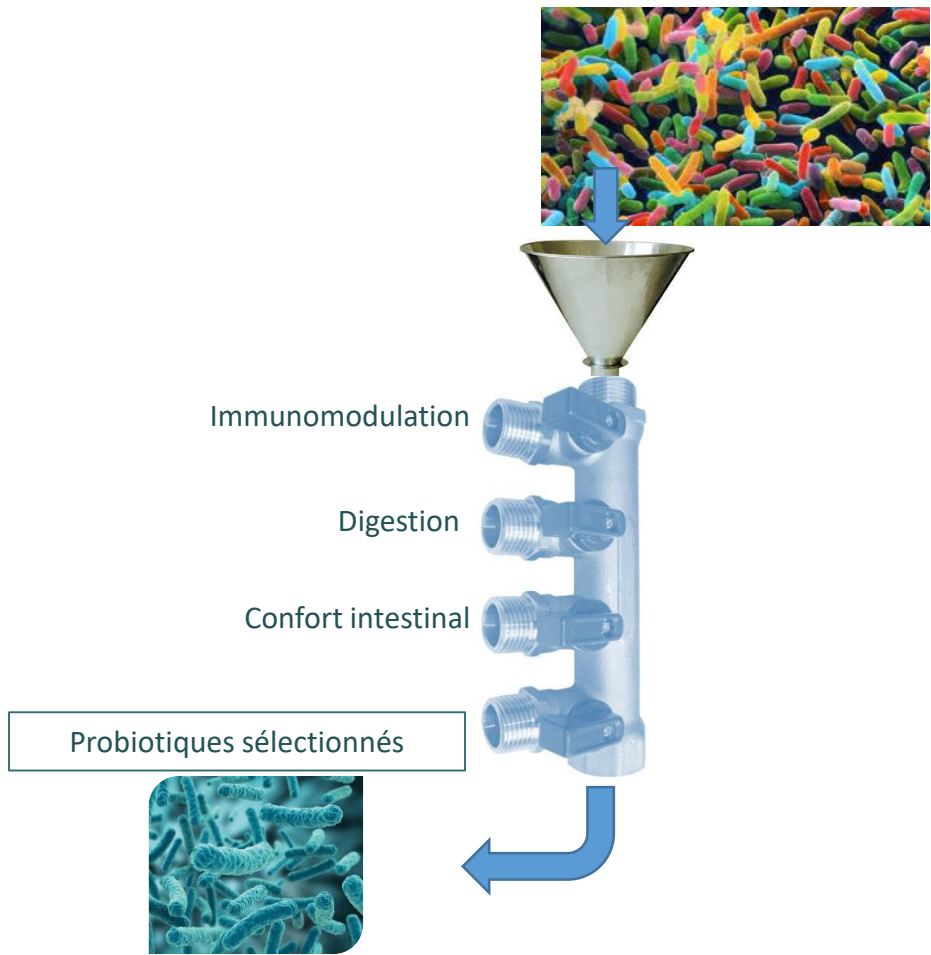
- Texture
- Arôme
- Acidification

Ferments sélectionnés

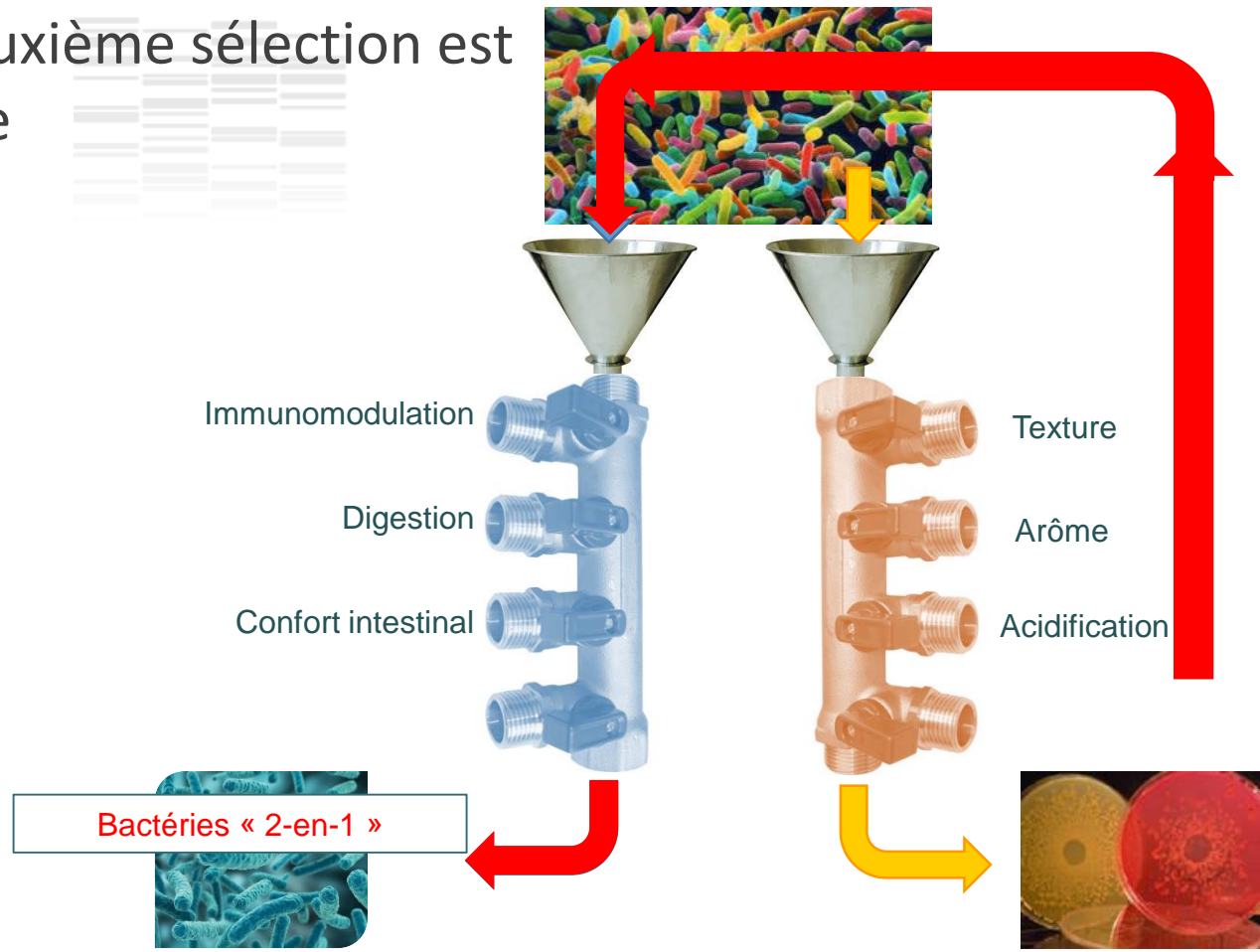


D'autres sélectionnent des bactéries "probiotiques"

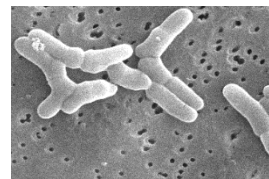
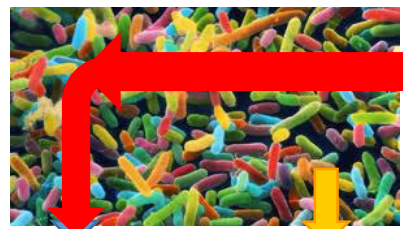
IBS, IBD, atopie, intolérance ...



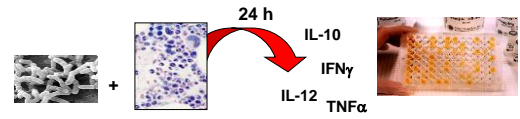
Une deuxième sélection est possible



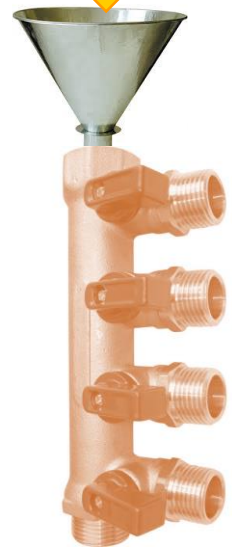
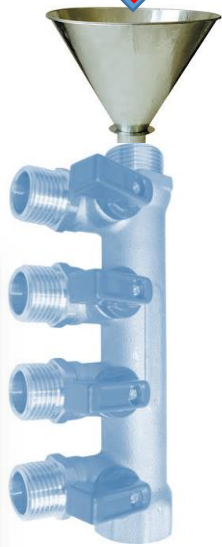
Un exemple : les propionibactéries



Propionibacterium freudenreichii



Immunomodulation



Texture

Arôme

→ Vitamines B9, B12



→ Bio-conservateurs



→ Ferments



Acides gras à chaîne courte

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*^{†‡}

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

Institut Pasteur de Lille, Lactic Acid Bacteria & Mucosal Immunity, Center for Infection and Immunity of Lille, 1, Rue du Pr Calmette, BP 245, F-59019 Lille, France¹; Université Lille Nord de France, F-59000 Lille, France²; CNRS, UMR 8204, F-59021 Lille, France³; Institut National de la Santé et de la Recherche Médicale, U1019, F-59019 Lille, France⁴; INRA, UMR1253 Science et Technologie du Lait et de l'Oeuf, F-35042 Rennes, France⁵; AGROCAMPUS OUEST, UMR1253 Science et Technologie du Lait et de l'Oeuf, F-35042 Rennes, France⁶; CNIEL/Synlait, 42 Rue de Châteaubleau, F-75314 Paris 09, France⁷; and EA 4427 SERRAIC, Faculty of Pharmacy, University of Rennes 1, IFR 140 GFAS, Rennes F-35043, France⁸

Received 20 August 2010/Accepted 7 October 2010

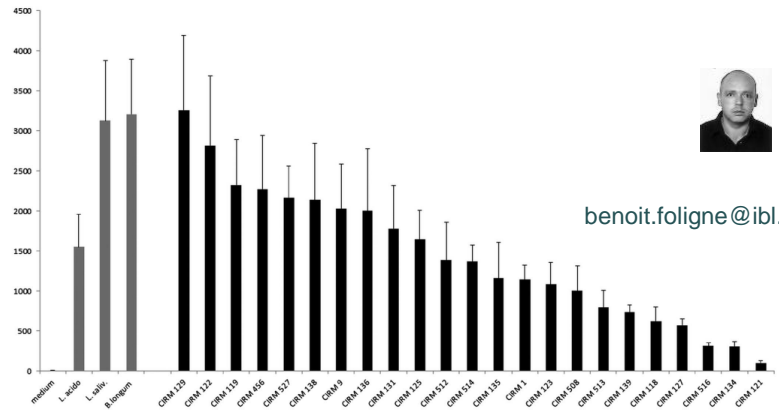
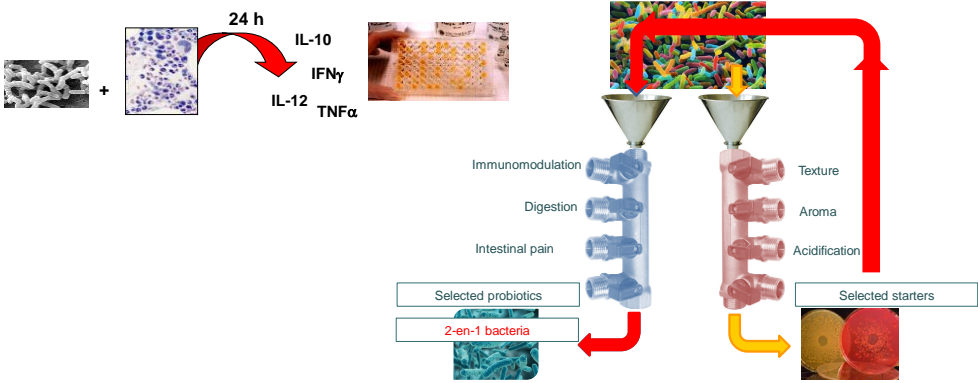
Immunomodulatory properties of 10 dairy propionibacteria, analyzed on human peripheral blood mononuclear cells (PBMCs), revealed a highly strain-dependent induction of anti-inflammatory cytokine interleukin 10 (IL-10). Two selected strains of *Propionibacterium freudenreichii* showed a protective effect against two models of colitis in mice, suggesting a probiotic potential predicted by immune-based selection criteria for these cheese starter bacteria.



benoit.foligne@ibl.cnrs.fr



Comment ça marche ?



benoit.foligne@ibl.cnrs.fr

Figure 1 Anti-inflammatory profile of dairy *Propionibacterium freudenreichii* strains assessed on human peripheral blood mononuclear cells (PBMCs). Comparative IL-10 release (in pg/ml) of human PBMCs for 3 reference benchmark probiotic strains (*Lactobacillus acidophilus* NCFM, *L. salivarius* LS33 and *Bifidobacterium longum* BB536) and for 23 propionibacteria strains (CIRM-BIA, INRA, Rennes, France). Immunocompetent cells were stimulated at multiplicity of infection of 10 for 24 h and supernatants analysed by ELISA. Detailed methodology was previously published.⁷

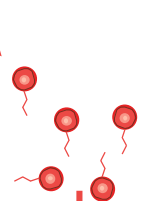
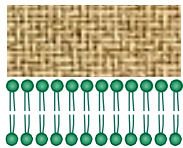
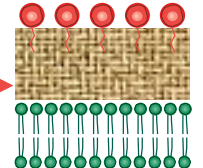
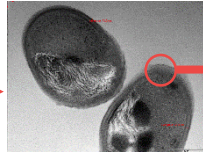
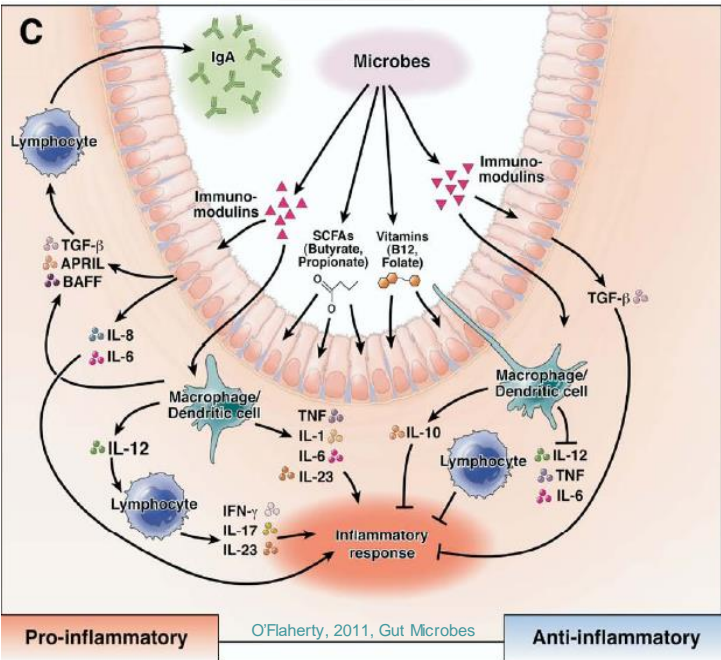
➤ Ça dépend de la souche

GUT 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

Un rôle clé des protéines de surface



IL-10 \uparrow

Inflammation

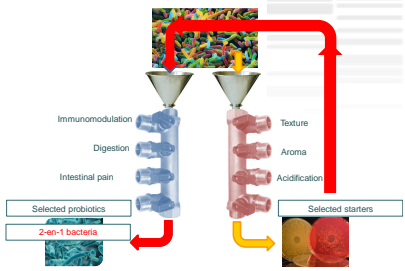
SURFING
Starter Surface
against Inflammation of the Gut

ANR



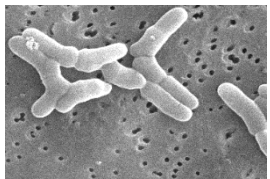
VALORIAL
LE PÔLE DE COMPÉTITIVITÉ AGROALIMENTAIRE
L'ALIMENT DE DEMAIN

Un autre exemple de « 2-en-1 »



APPLIED AND ENVIRONMENTAL MICROBIOLOGY, Dec. 2010, p. 8259–8264
 0099-2240/10/\$12.00 doi:10.1128/AEM.01976-10
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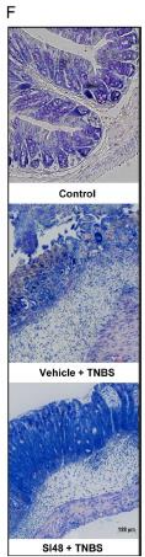
Propionibacterium freudenreichii



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

On en a fait tout un fromage!!!



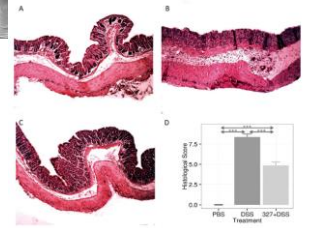
Lactobacillus delbrueckii

OPEN ACCESS Freely available online

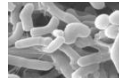


Local and Systemic Immune Mechanisms Underlying the Anti-Colitis Effects of the Dairy Bacterium *Lactobacillus delbrueckii*

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



Un fromage gnotobiotique par ingénierie inverse



Lait
↓
Poudre 100 g/L
↓
Crème 150 g/L
↓
Stérilisation
↓
Culture *P. freudenreichii*
30°C, 72 h
↓
Pré-fromage

Lait UHT
↓
Culture *L. delbrueckii*
42°C, 4 h
↓
Lait fermenté

Coagulation, brassage,
cuisson, moulage,
pressage, emballage,
affinage



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

DOI 10.1002/mnfr.201500580

935

RESEARCH ARTICLE

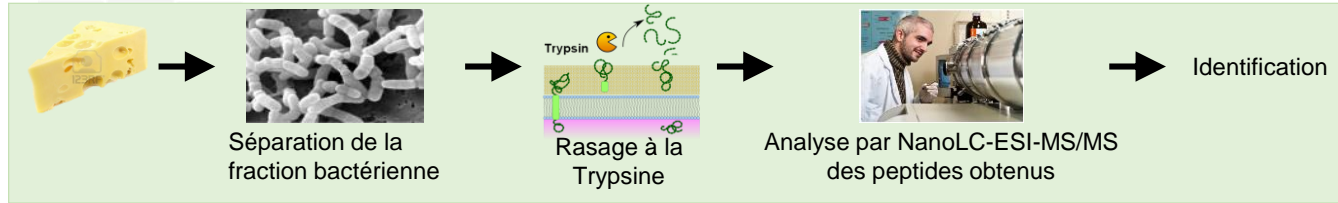
Molecular Nutrition
Food Research

**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

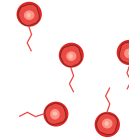


Des protéines clés exprimées dans le fromage

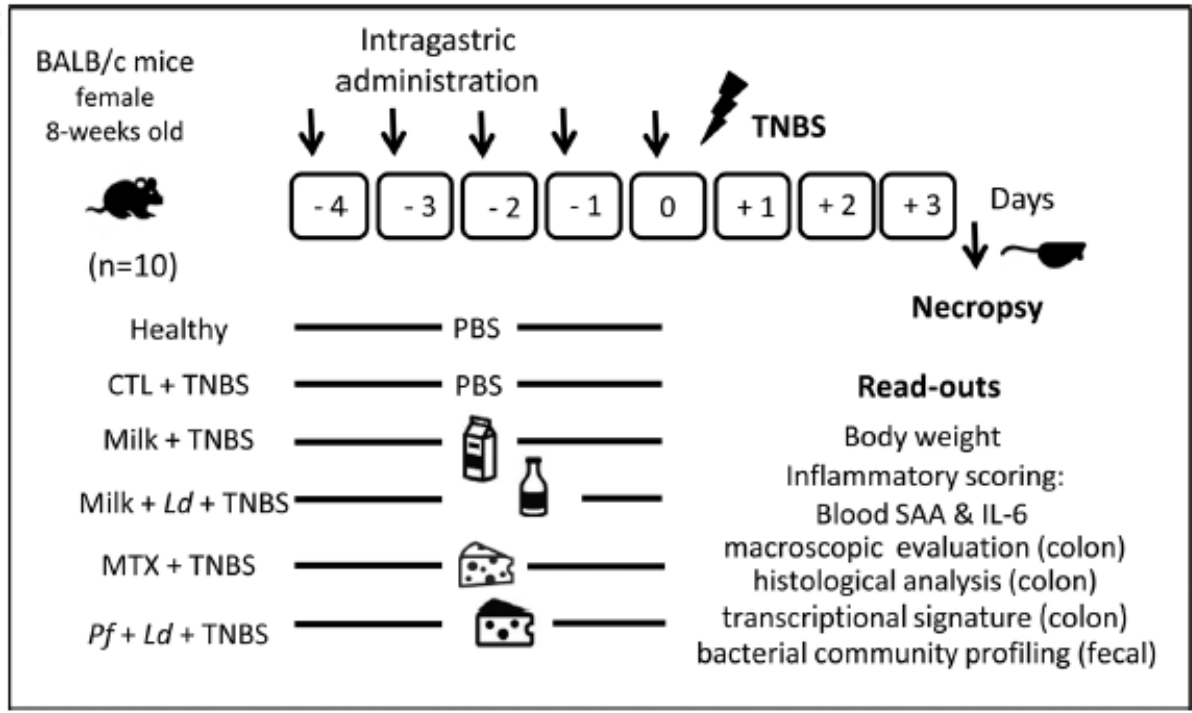


Description	Function	Gene	log(E value)	Peptides	PAI	Group	Sub-group
Surface layer protein B	Cell wall	slpB	-569,10	81	77,3	1	1.1
Surface protein with SLH domain	Cell wall	slpE	-271,21	40	21,5	1	1.2
Surface layer protein A	Cell wall	slpA	-7,48	3	0,6	1	1.3
Internaline A	Miscellaneous	inIA	-838,69	103	26,9	2	2.1
Heat shock protein 20 2	Protein folding	hsp20 2	-69,41	10	19,9	3	3.1
60 kDa chaperonin 2	Protein folding	groL2	-275,04	36	17,0	4	4.1
60 kDa chaperonin 1	Protein folding	groL1	-371,42	49	14,8	4	4.2
Cold shock-like protein CspA	Adaptation to atypical conditions	cspA	-28,17	3	15,5	5	5.1
methyltransferase	Miscellaneous		-66,29	7	15,0	6	6.1
Methylmalonyl-CoA mutase large s	Specific carbohydrate metabolic pathway	mutB	-331,83	43	14,1	7	7.1
Elongation factor Tu	Translation elongation	tuf	-177,14	23	13,6	8	8.1
50S ribosomal protein L7/L12	Ribosomal proteins	rplL	-79,13	10	13,2	9	9.1
Lsr2-like protein	Miscellaneous		-24,65	3	13,0	10	10.1
30S ribosomal protein S9	Ribosomal proteins	rspl	-74,75	12	12,4	11	11.1
30S ribosomal protein S7	Ribosomal proteins	rpsG	-77,54	14	11,5	12	12.1
Hypothetical protein	Protein of unknown function		-183,92	23	10,8	13	13.1
30S ribosomal protein S1	Ribosomal proteins	rpsA	-214,68	27	10,7	14	14.1
ErfK/YbiS/YcfS/YnhG precursor	Cell wall		-120,71	20	10,4	15	15.1
NAD(P)(+) transhydrogenase	Metabolism of coenzymes and prosthetic groups	pntA	-146,56	19	10,4	16	16.1
50S ribosomal protein L35	Ribosomal proteins	rpmI	-17,33	4	10,0	17	17.1

Protéines de surface impliquées

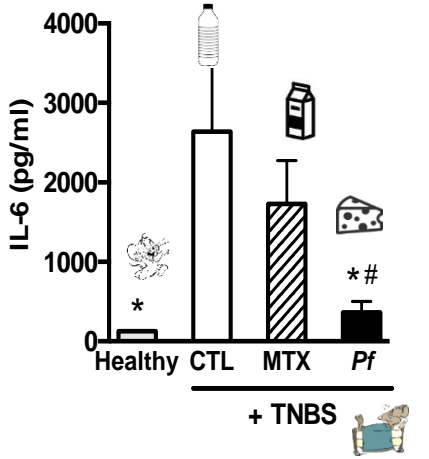


Un fromage testé dans un modèle animal de colite

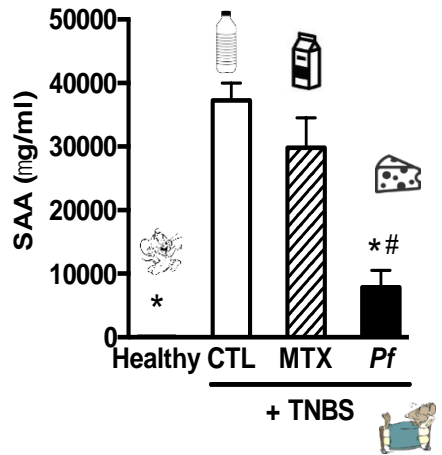


Au niveau systémique

Marqueurs de l'inflammation



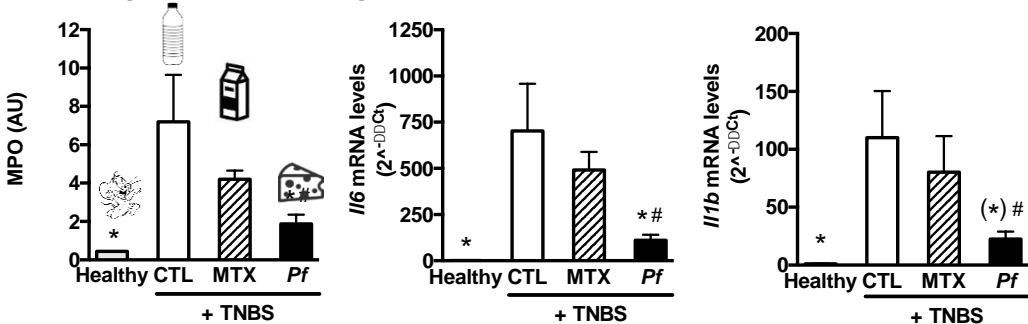
Interleukine 6



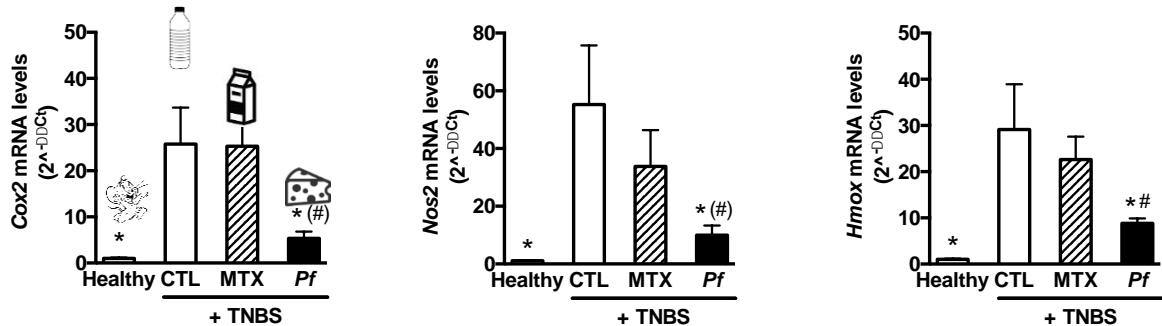
Serum Amyloid A

Au niveau colique

Marqueurs coliques d'inflammation



Marqueurs coliques de stress oxydatif



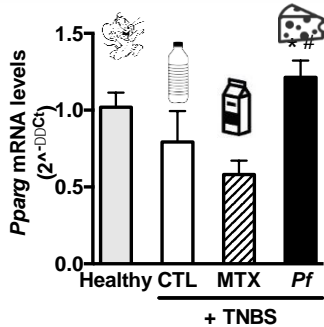
* p<0.05: vs CTL
p<0.05: vs MTX

Au niveau cellulaire

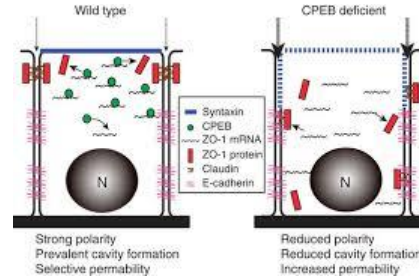
Marqueurs de cellules épithéliales



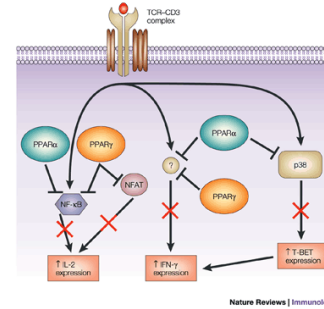
Mais c'est toujours un fromage de labo!



Nagaoka, Nature Communications, 2012

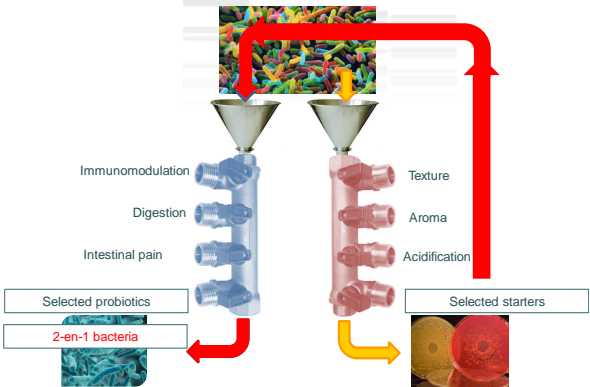


Les protéines de zona occludens (ZO-1, ZO-2 and ZO-3) : les clips des jonctions serrées



Peroxisome proliferator-activated receptors (PPARs) : régulation de l'inflammation intestinale

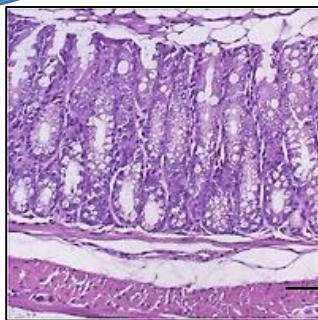
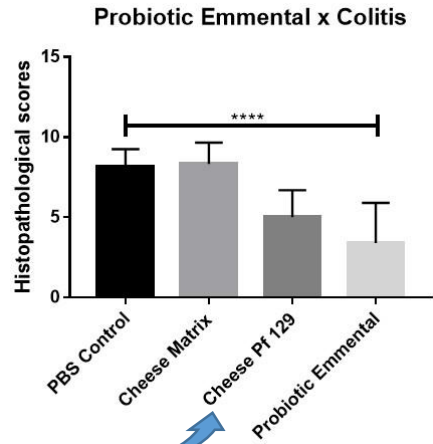
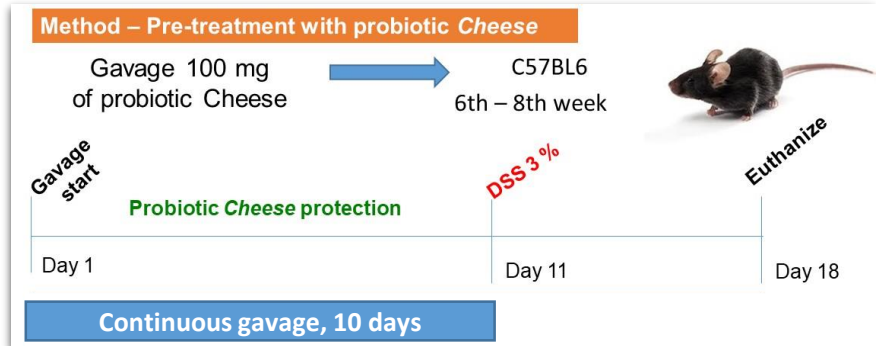
Faisons un vrai Emmental



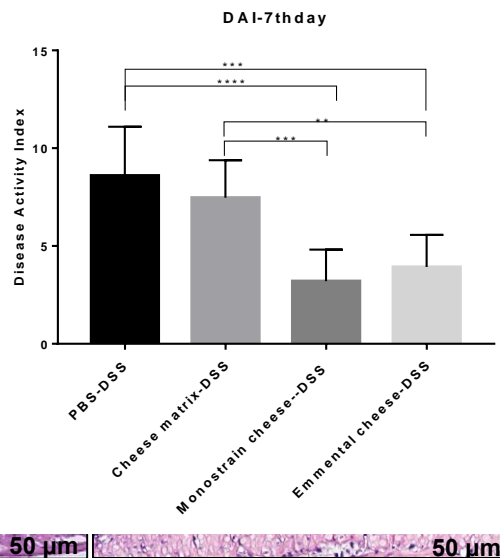
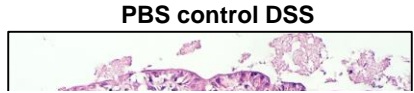
Propionibacterium freudenreichii
Streptococcus thermophilus
Lactobacillus delbrueckii



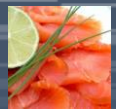
L'Emmental protège dans le modèle de colite souris / DSS



Noninflamed control



Probiotic Emmental



Aliments fermentés : 30% de notre alimentation

Une source majeure de bactéries : 10¹⁰ per day!



Une grande variété de bactéries, de molécules bioactives

Des perspectives en nutrition personnalisée



Houem Rabah

Fillipe do Carmo

Song Huang

Floriane Gaucher



Merci pour votre attention!

