

The impact of food processing on the quality of food and health effects on the digestive tract

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PROSPECTS FOR THE 3RD MILLENNIUM AGRICULTURE

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Summary

- Food processing
- Part 1: Nutritional and organoleptic impact of cooking
- Part 2: Formulation and impact on bioavailability
- Part 3: Cooking by-products and impact on biological activities
 - Microbiota
 - Inflammation
 - Cancer promotion
- Conclusions

Food processing

- Two processes are of interest for our research group:
 - Transformation of the product through heat
 - The composition of raw material can impact the concentration of by-products
 - The duration and temperature of heat treatment can impact the nature of by-products
 - Transformation of the product through formulation
 - The matrix plays a role in the bioavailability of the active molecules

Part 1: Nutritional and organoleptic impact of cooking

Effect of added nitrogen fertilizer on pyrazines of roasted chicory

Céline Jouquand,^{a*} Céline Niquet-Léridon,^a Grégory Loaec^a and Frédéric Jacques Tessier^b

- The addition of 120 kg ha⁻¹ of nitrogen fertilizer in the field resulted in a greater amount of pyrazines in the roasted chicory.
- The chicory odor was modified in two out of five varieties.

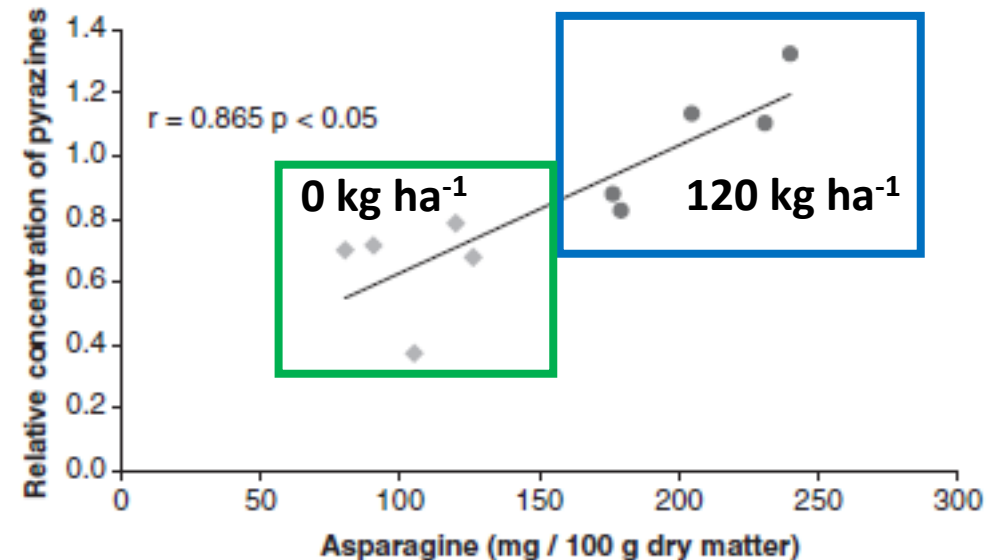
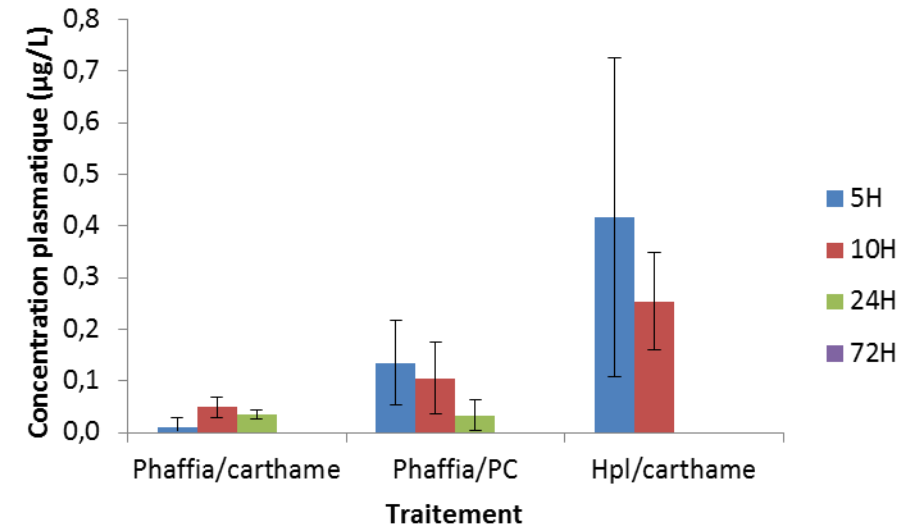
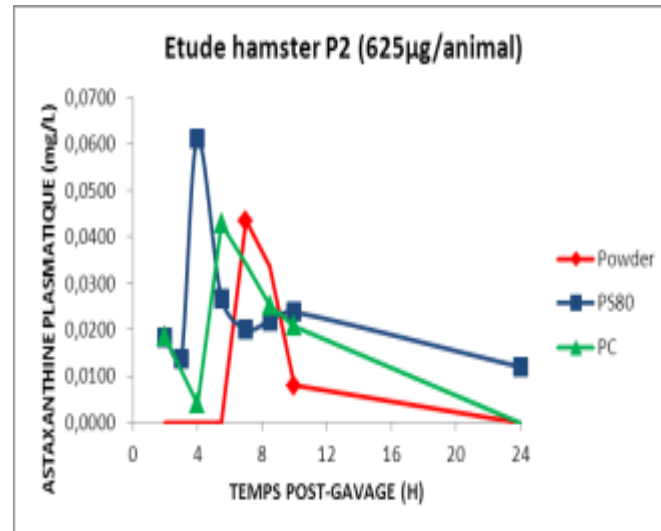


Figure 1. Relationship between free asparagine content and the relative concentration of pyrazines in roasted chicory from five commercial varieties grown under 0 kg ha⁻¹ (◆) and 120 kg ha⁻¹ (●) of added nitrogen in 2011. The plot shows Pearson's correlation with the *r*- and *P*-values.

Part 2: Formulation and bioavailability



Bioavailability of two sources of astaxanthin; preclinical data



Hamsters study, AX fed in capsules

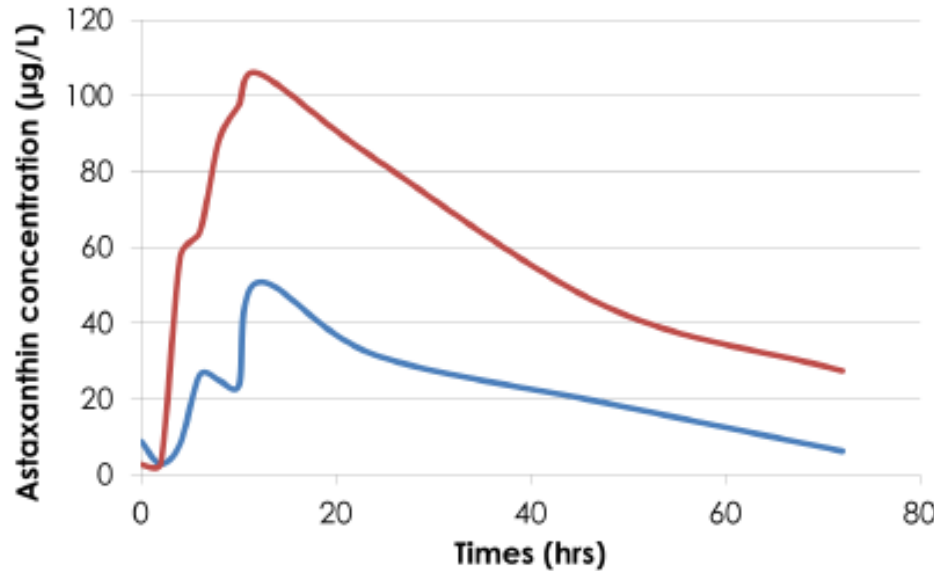
- Matrix effet
 - Powder delays absorption in plasma
 - Lipids do not have same AUC

Rat study, AX fed by gavage

- Structure effect
 - *P. rhodozyma* less absorbed than *H. pluvialis*
 - Lipids do not have same AUC



Bioavailability of two sources of astaxanthin; clinical data



Product	Subjects (n)	AUC (µg*h/l)	Cmax (µg/L)	Tmax (hrs)
AX-PR	12	1633,8 (1215,3)	72,7 (94,0)	12,8 (6,9)
AX-HP	12	4255,5 (1678,7)	159,9 (104,7)	12,8 (7,2)
(p)		p=0.008	p=0,034	p>0.05

Data is presented as mean and standard error (in brackets) of 12 measures for each of the parameters.

Human study, AX fed in capsules at 48mg

- Structure effect
 - *P. rhodozyma* less absorbed than *H. pluvialis*
- Role of extraction and formulation processes

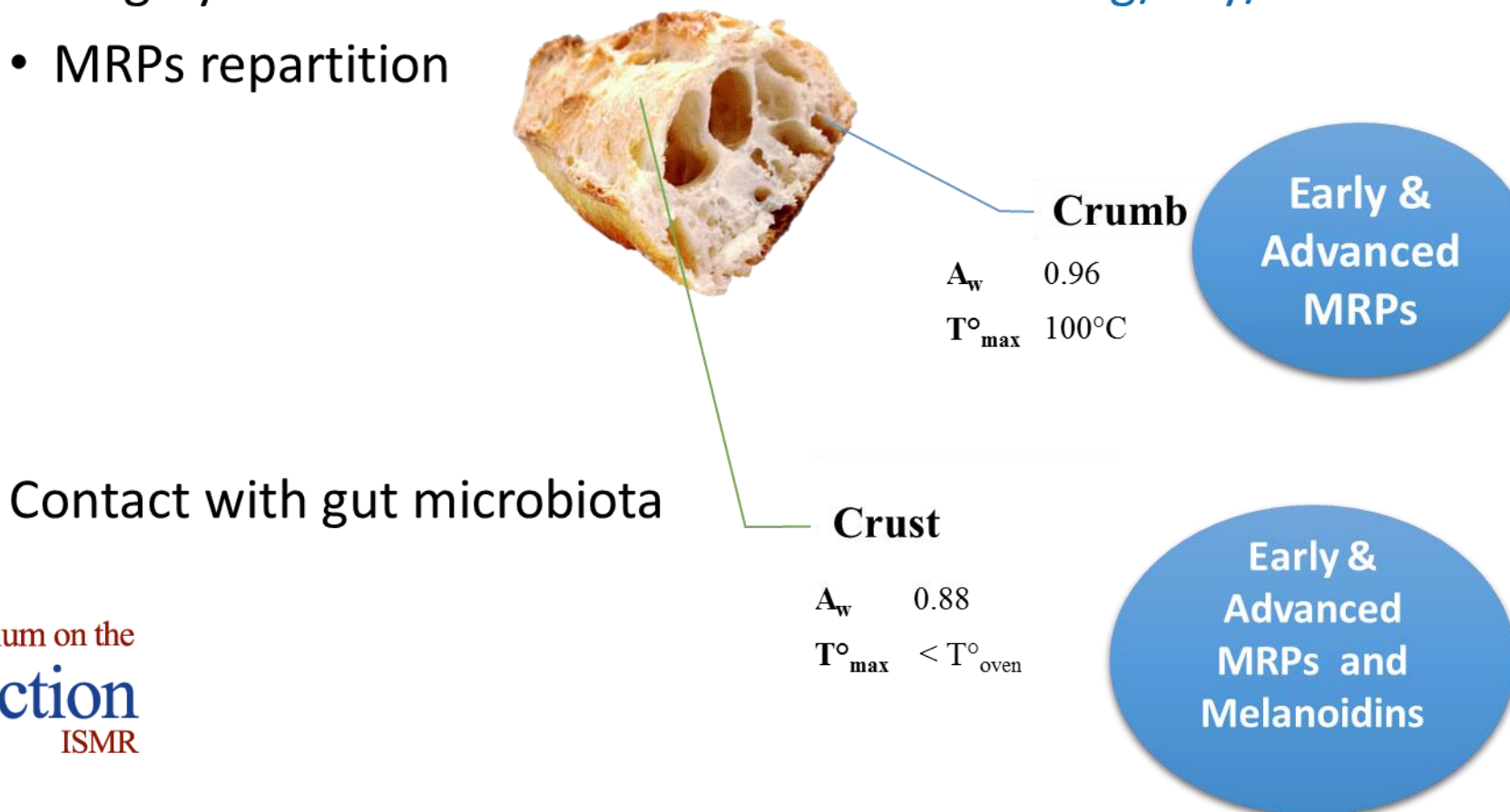
Part 3: Biological activities

Bread MRPs and gut microbiota: focus on *Enterobacteriaceae*

C. Helou, P. M. Anton, S. Denis, M. Spatz, D. Marier, V. Rame,
M. Alric, F. J. Tessier and P. Gadonna-Widehem



- Source of carbohydrates, vitamins, minerals and fibers
- Largely consumed food item with almost **160g/day/habitant**
- MRPs repartition




Part 3: Biological activities

- some advanced glycation end-products (AGEs, e.g. melanoidins) have shown prebiotic activity.
- early AGEs seem to have ambiguous impact on colic inflammation
- different fractions of heat-treated food have shown cancer-promoting properties.

Microorganisms and Maillard reaction products: a review of the literature and recent findings

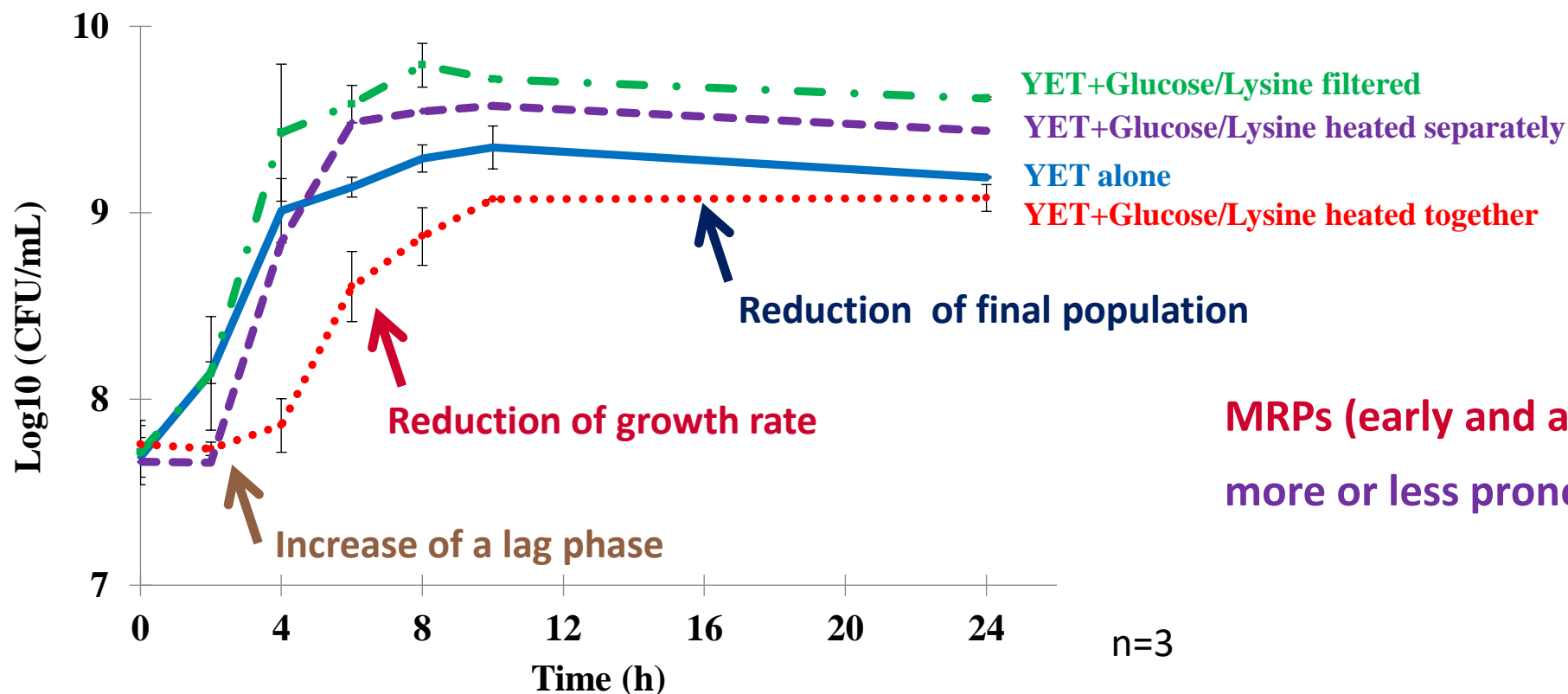
Authors

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Escherichia coli CIP 54.8

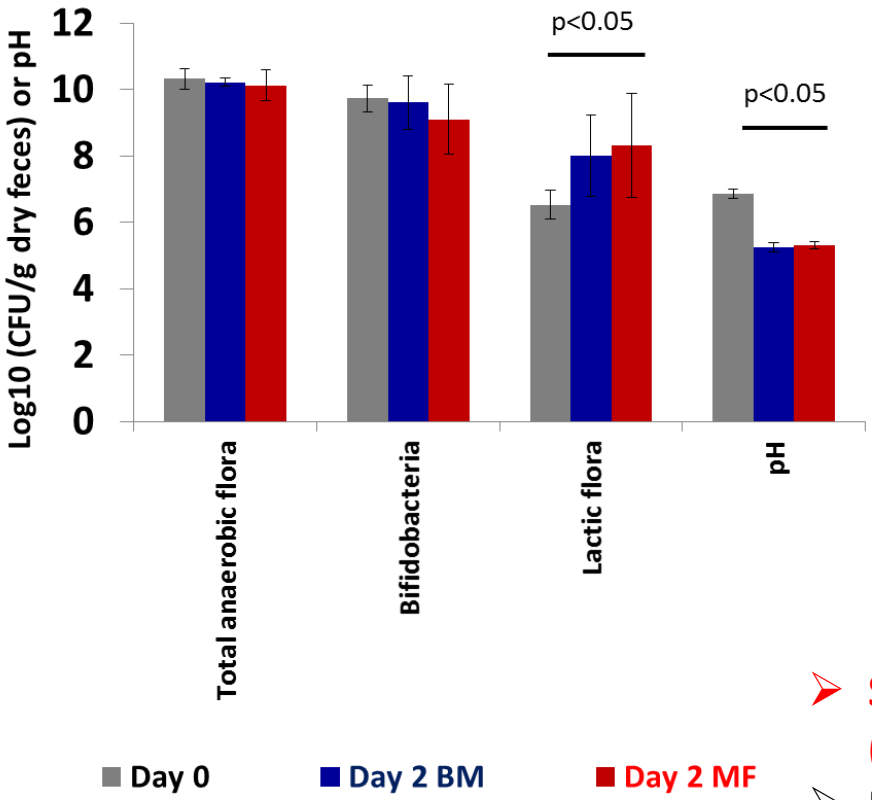


MRPs (early and advanced) → -ve impact /strains more or less pronounced depending on the strain

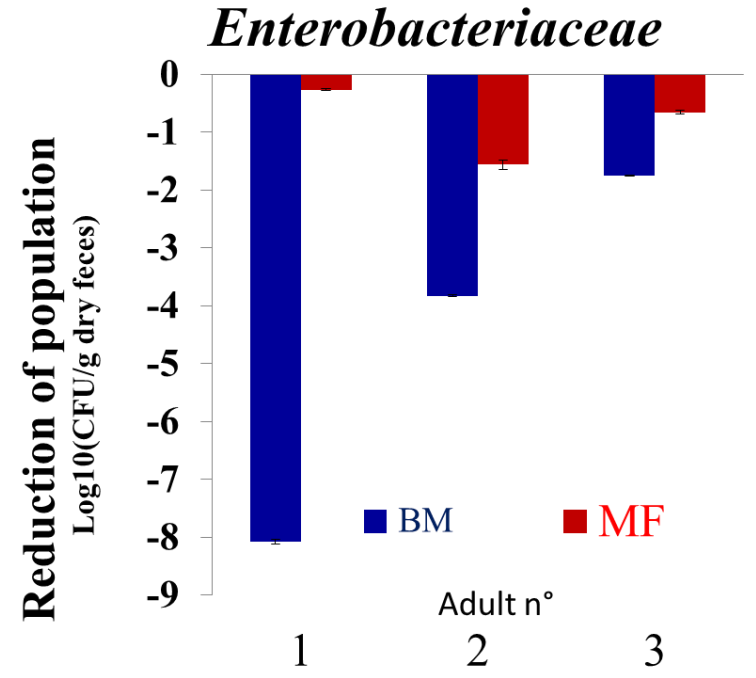


Insights into bread melanoidins: fate in the upper digestive tract and impact on the gut microbiota using in vitro systems.

Helou C¹, Denis S, Spatz M, Marier D, Rame V, Alric M, Tessier FJ, Gadonna-Widehem P.



- **Stability of total anaerobic flora (no stress during fermentation)**
- **No change on « potential benefic bacteria » such as Bifidobacteria**
- **Increase of Lactic acid Bacteria associated with decrease of pH**






- **A decrease of enterobacteria in the two tested conditions was observed whatever the subject**
- **A higher reduction of *Enterobacteriaceae* in presence of bread melanoidins (BM)**

Part 3: Biological activities

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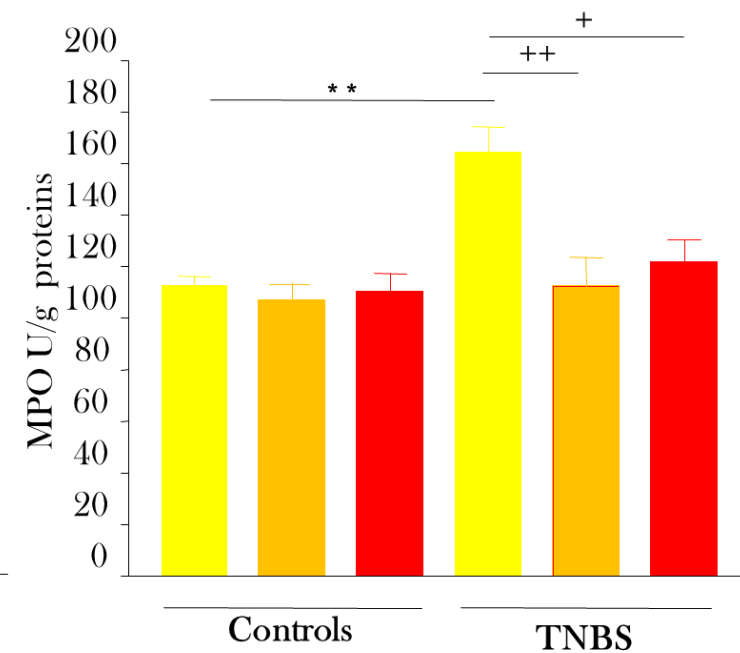
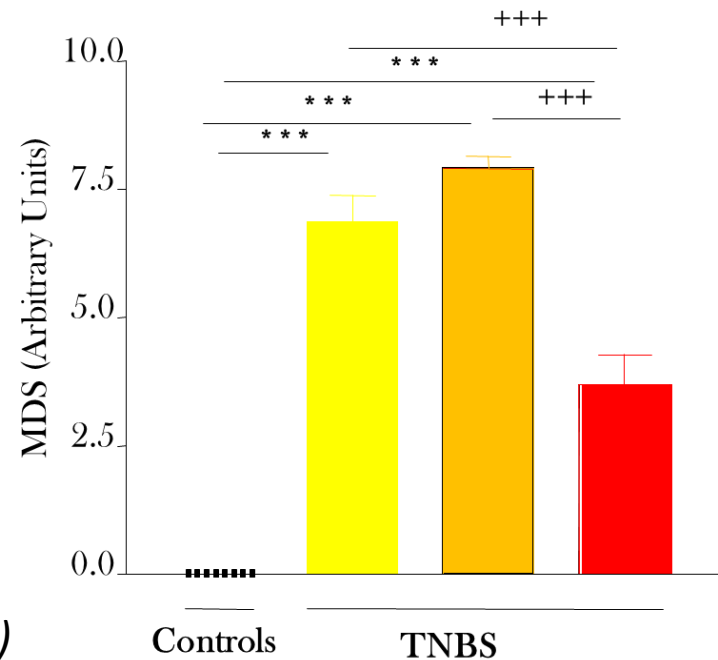
Maillard Reactions Products From Thermally Processed Foods Contributes to Limitation of Experimental Colitis in Mice

Issam Al Amir, Celine Niquet-Leridon, Frederic J. Tessier, Pauline M. Anton

	Non Heated (NH) 	Mildly Heated (MH) 	Highly Heated (HH) 
Thermic treatment	-	Oven: 1h30, 150°C, 1/3 H2O	Oven: 4h, 150°C, 2/3 H2O
AGEs (µg CML/5g food *)	69	135 (x2)	284 (x4)
Browning, Melanoidins (AU)	11.7	12.2 (+1)	13.3 (+2)

** , *** significantly different (p<0.01, p<0.001) from respective control diet
 +, ++, +++ significantly different (p<0.05, p<0.01, p<0.001) from TNBS-treated mice

- Inflammation reduced in HH diet
- Pro-inflammatory marker (MPO) reduced with both MH and HH diets



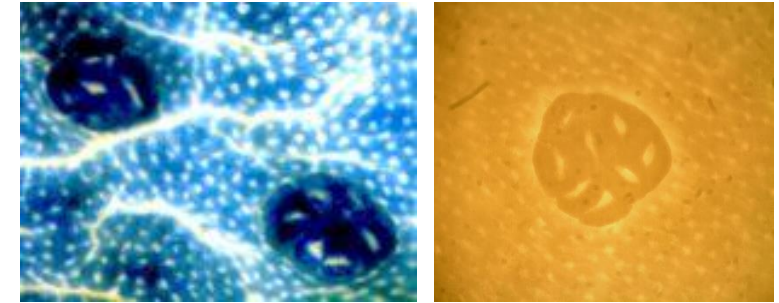
I AL AMIR et al, *Gastroenterology* (2011)

Part 3: Biological activities

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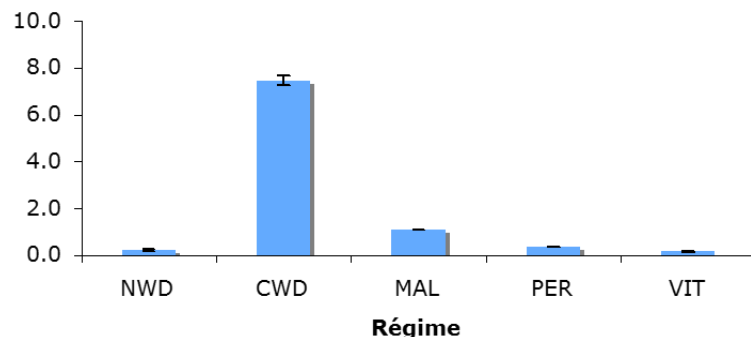
Dietary Sources of Oxidative Stress and their Consequences on Colon Cancer (F. DEPEINT, 2008)

	NWD	CWD (diluted ½)	MAL	PER	VIT
Hyp:	Groupe contrôle (Newmark) Western Diet	Régime WD Cuit au four 1h30, 170°C	Produits MAillard (sucre et caséine cuits)	PERoxydes lipides (huile et minéraux cuits)	Déficiences VITamines (1/4 de la dose WD)
N=	20	20	20	20	20



	NWD	CWD	MAL	PER	VIT
ACF (incid.)	4/20	0/20 <	4/20 =	3/20 =	0/20 <
TBARS (uM eq.)	105	212 X2	154 X1.5	108 =	112 =
Cytotox (dilution)	20-30	140-160 X8	30 >/=	30 >/=	20-30 =
Morpho (densité)	0.21 0.33	0.15 < 0.23 <	0.19 = 0.23 <	0.21 = 0.34 =	0.19 = 0.32 =

TBARS dans les Aliments




- No increase in spontaneous ACF formation with cooking
- But data suggest generalised dysplasia over the whole surface of colon
- Associated with increased oxidative stress

Conclusions

- The different experiments have shown the importance of understanding not only the theoretical aspects of the individual bioactive compounds but also the role of the global matrix and food processing on the food composition, with the formation of new molecules and disappearance of some nutrients, and their consequences for the consumer.

 inflammatory effect of MRPs such as CML.

 prebiotic and antioxidant effects of dietary melanoidins.

My thanks to all lecturers, researchers, engineers, technicians, postdoctoral fellows, postgraduate students and undergraduate students for their work and the possibility to present their data here today.

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Expression de gènes et régulation épigénétique par l'aliment

UP 2012.10.101

Les travaux de l'équipe de recherche visent à préciser, chez les femmes enceintes et les enfants, les effets des facteurs environnementaux d'origine alimentaire.