UNIVERSITY OF THE AEGEAN

Food formulation & microbes for controlling flavour development:
case studies of starter cultures in emulsions

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- **2019 – Present** — **University of Aegean (& UoB)**
- **2013-2019** — **University of Birmingham**
- **2009-2012** — **University of Northampton**
- **2008** — **KTP Associate**
- **2005** — **PhD – Division of Food Science**
- **2004-2005** — **Food industry - technology & quality control**
- **2004** — **BSc Food Science - Greece**

University of the Aegean

- Public university founded in 1984
- Combines campuses across six islands of the Aegean Sea.
- Administrative headquarters in Lesvos Island
- Five Schools and 18 Departments
- > 10,000 active students
  ~ 8,000 undergraduate
  ~ 2,000 postgraduate
  ~ faculty 500
- Department of Food Science and Nutrition at ***Lemnos*** **island**

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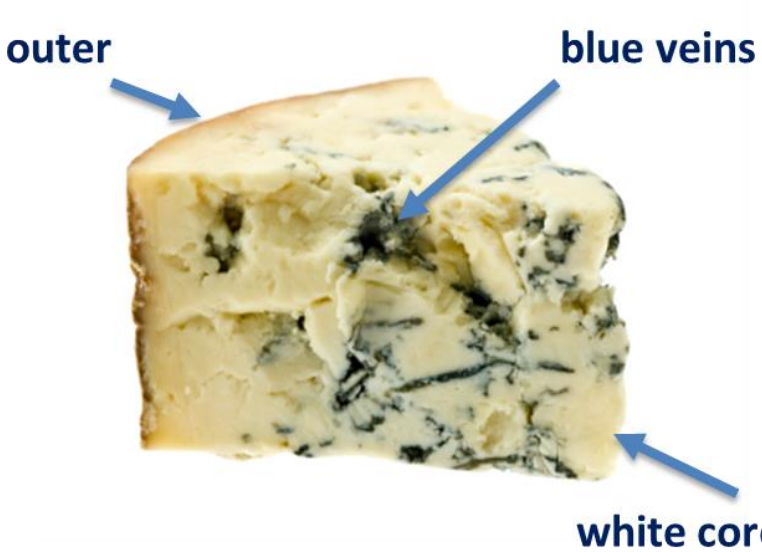
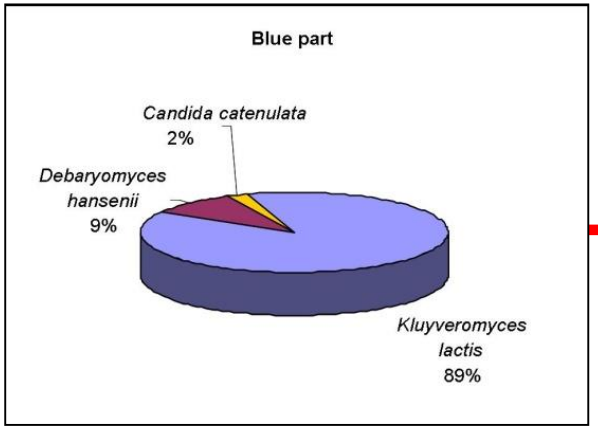
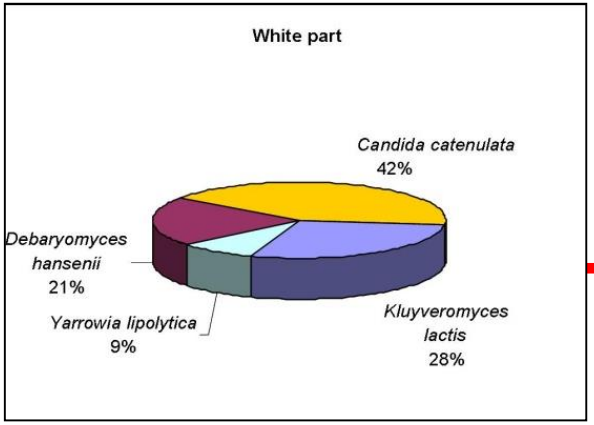
…we consume based on branding

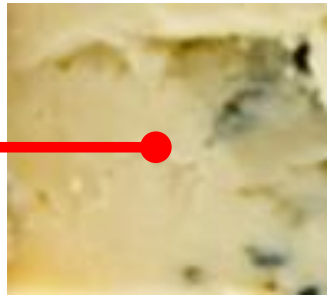
…what is the share of microbes in fermented food

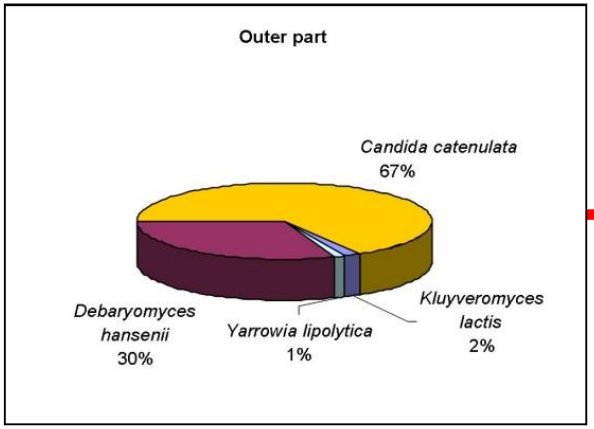


DNA-based microbial analysis of the yeasts in Stilton









Example of typical fermented food:

- Starter culture
- Secondary culture
- Links of its microbes to flavour
- Diverse food structure
- Principals that apply to many fermented foods

Flavour

Interactions in models

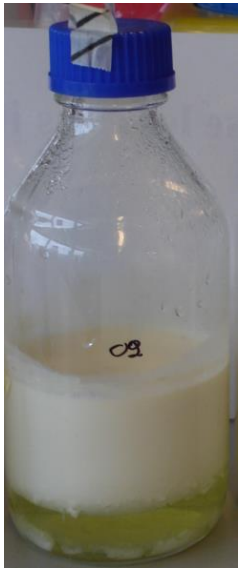
Yeasts (secondary microflora)

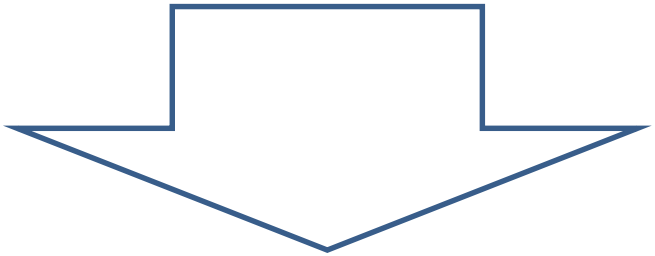
- *Kluyveromyces lactis*
- *Debaryomyces hansenii*
- *Trichosporon beigelii*
- *Yarrowia lipolytica*

+

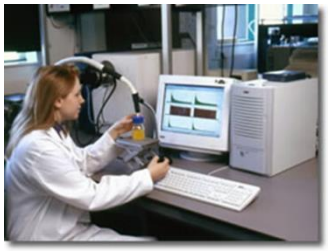
Starter mould

Penicillium roqueforti





- GC-MS



- APCI-MS

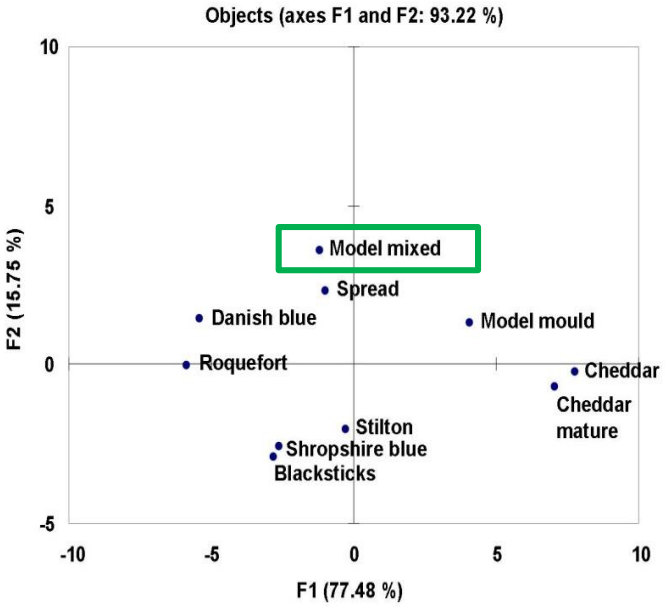
- Sensory

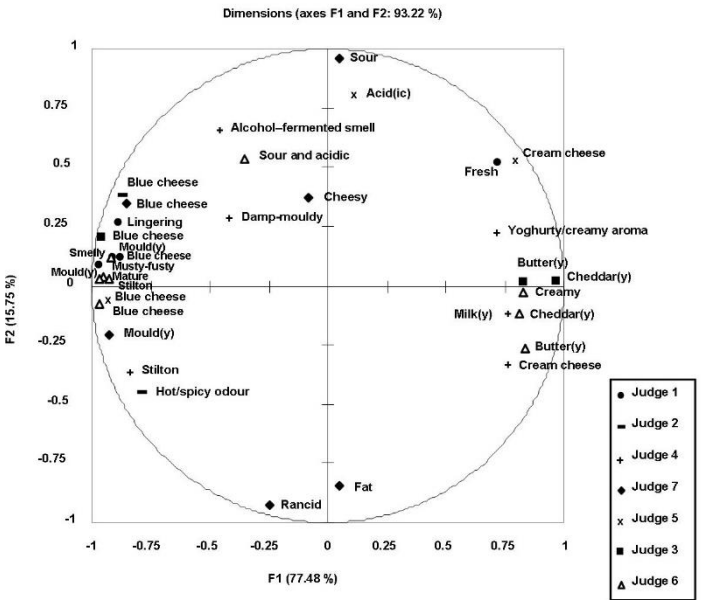
Comparison of models and real cheese aroma - GC-MS analysis

VS.

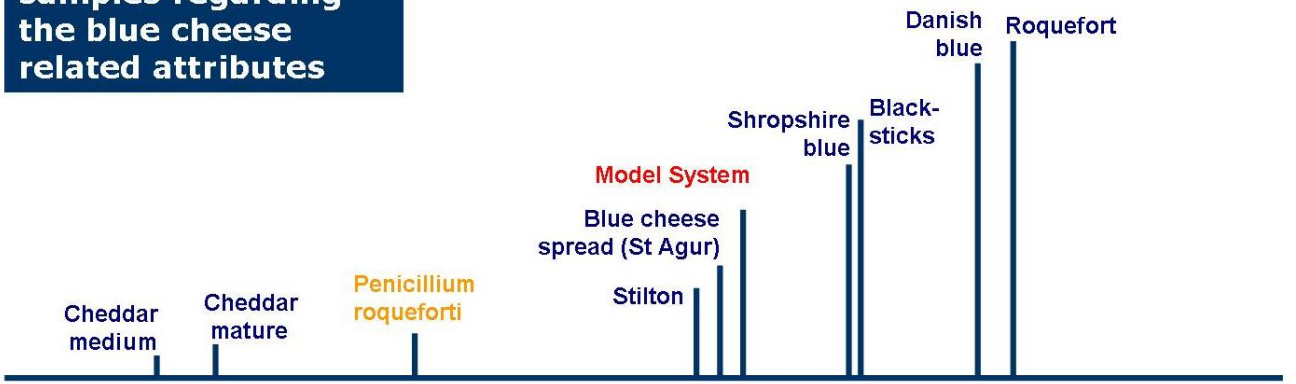
Food Chemistry
Volatile profile of Stilton cheeses: Differences between zones within a cheese and dairies
Konstantinos Gkatzionis *, Robert S.T. Linforth, Christine E.R. Dodd

Sensory - Flash profile

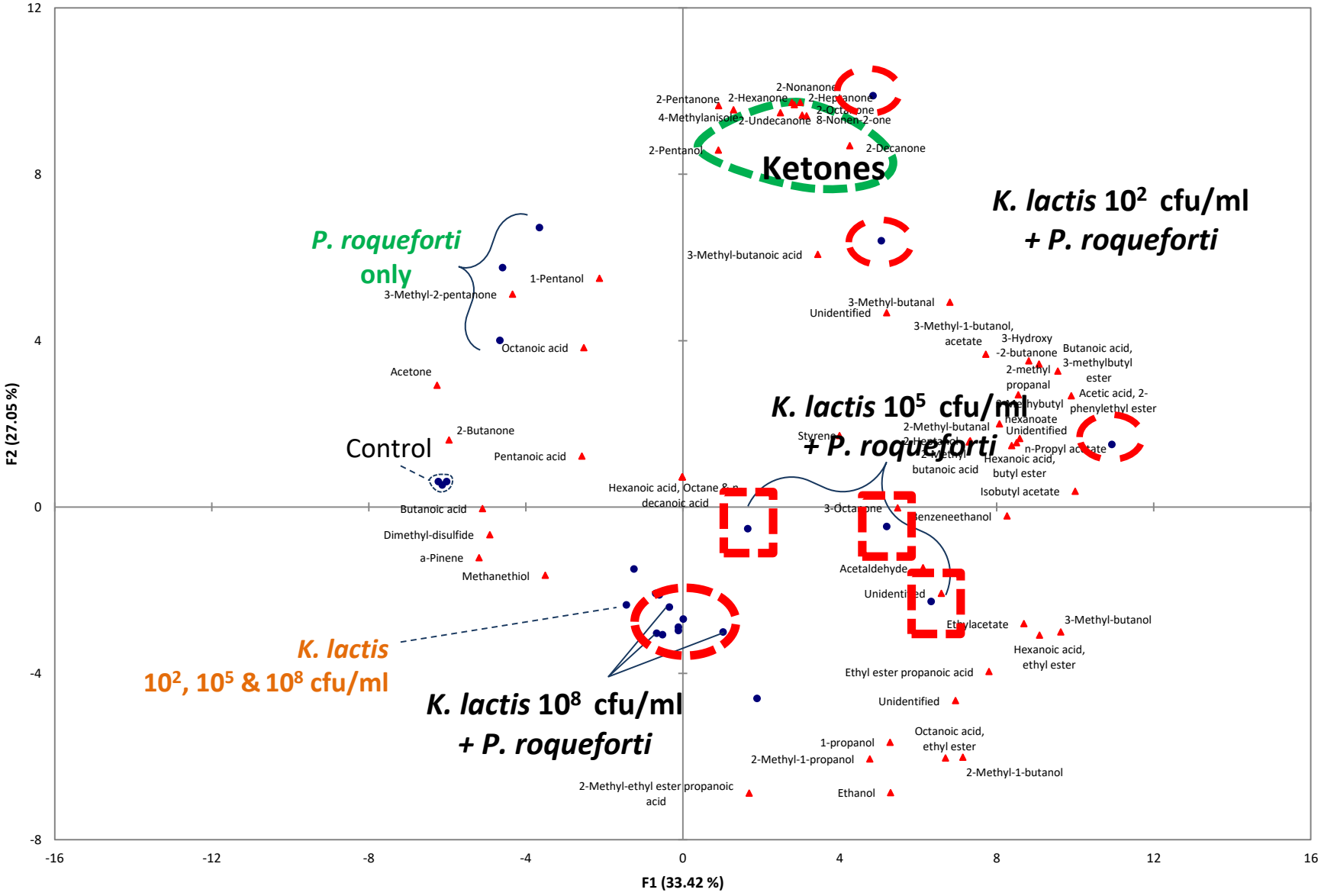




Relative position of samples regarding the blue cheese related attributes



Effect of quantity – Aroma profiles of *Kluyveromyes lactis in* models



Contents lists available at ScienceDirect
Food Chemistry
journal homepage: www.elsevier.com/locate/foodchem
Study of the influence of yeast inoculum concentration (*Yarrowia lipolytica* and *Kluyveromyces lactis*) on blue cheese aroma development using microbiological models

Conclusions…

Interactions of starter and secondary culture in fermented food are like…

There is a starter culture
- this is needed

There is a secondary culture
- this is desirable
- we do not control it

Interesting things happen when both are ensured
- …however, they can not co-exist due to competing with each other

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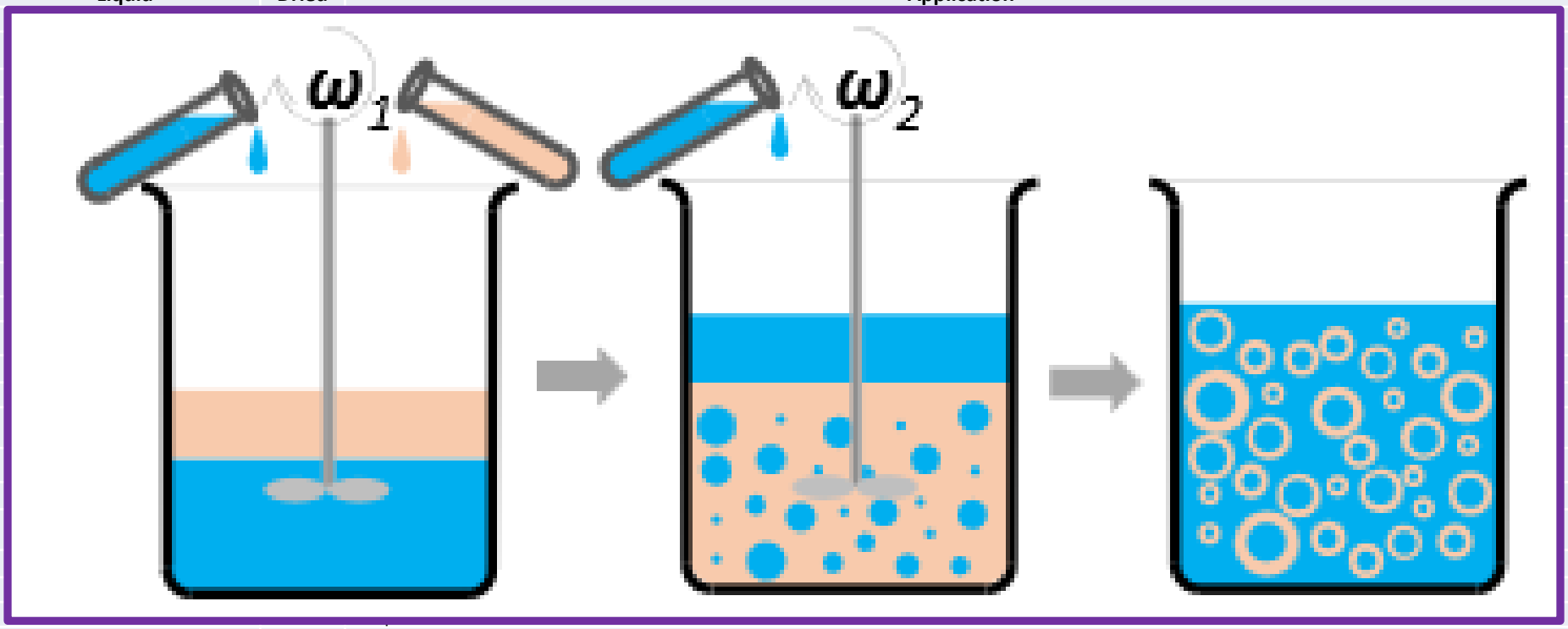
Double Emulsions Relevant to Food Systems: Preparation, Stability, and Applications

Gerald Muschiolik, Eric Dickinson



Liquid	Dried	Application
	X	Microencapsulation of fish oil
x		Tailoring oral destabilization of DE with NaCl in W1 in order to enhance saltiness perception (application for sodium reduction in food)
X		Replacement of oil by water droplets in oil phase to manipulate sensory response (intensity of fat-related attributes)
X		Encapsulation of caffeine in yogurt
X		Replacement of beef fat in meat emulsion system
X		Encapsulation of probiotic bacteria L. salivarius (W1 consists of solid-phase (S) dried cells)
X		Replacement of pork fat in frankfurters with DE containing perilla oil (high content of α-linolenic acid)
X		Beverage with 1% DE as clouding agent, with 60% sucrose as weighting agent in W1 phase, and orange oil or medium-chain triglycerides as O phase
X		Enrichment of skim milk with sunflower oil
X		Encapsulation of Lactobacillus delbrueckii

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Double Emulsions Relevant to Food Systems: Preparation, Stability, and Applications

Gerald Muschiolik, Eric Dickinson

Liquid	Dried	Application
X		Low-calorie cream or mayonnaise
X		Double emulsion containing gelling polysaccharide and encapsulated flavor, applicable to low-fat salad dressing or margarine-like spread
X		Formation of W/O/W emulsion by diluting O/W microemulsion (with nonmiscible flavoring substances), suitable for food flavoring purposes
X		Carrier for vitamins in sweets (40% sugar in W phase)
X		Replacement of milk fat in cheese
X		Carrier for sodium ascorbate in ultra-high temperature milk (3% DE in milk)
X		Carrier for CaCl2 in soybean milk in order to influence consistency
	X	Edible film with mechanical properties comparable to hydrophilic film, but with water vapor permeability
X		Carrier for omega-3 polyunsaturated fatty acids (chia essential oil) or ascorbic acid
X		Encapsulation of natural coloring agents for confectionery, fruit preparation, ice cream
X		Spread enriched with fish oil
	X	Powder with microencapsulated peanut sprout extract (containing high content of resveratrol)
X		Encapsulation of vitamin B12 to produce functional dairy products
X		Encapsulation of seasoning particles (4 to 25 μm)
	X	Powdered additive for chewing gum with encapsulated aspartame to prolong perception of sweet taste
X		Pork backfat replacers in meat gel/emulsion model systems with olive oil as lipid phase
X		Bittern solution (MgCl2) in W1 phase as a coagulant for tofu preparation
	X	Encapsulation of xylitol and menthol in chewing gum to prolong cooling effect and flavor perception duration
X		Encapsulation of curcumin and catechin in beverage systems
	X	Encapsulation of grape seed extract (procyanidins)
	X	Encapsulation of saffron extract
	X	Microencapsulation of fish oil
x		Tailoring oral destabilization of DE with NaCl in W1 in order to enhance saltiness perception (application for sodium reduction in food)
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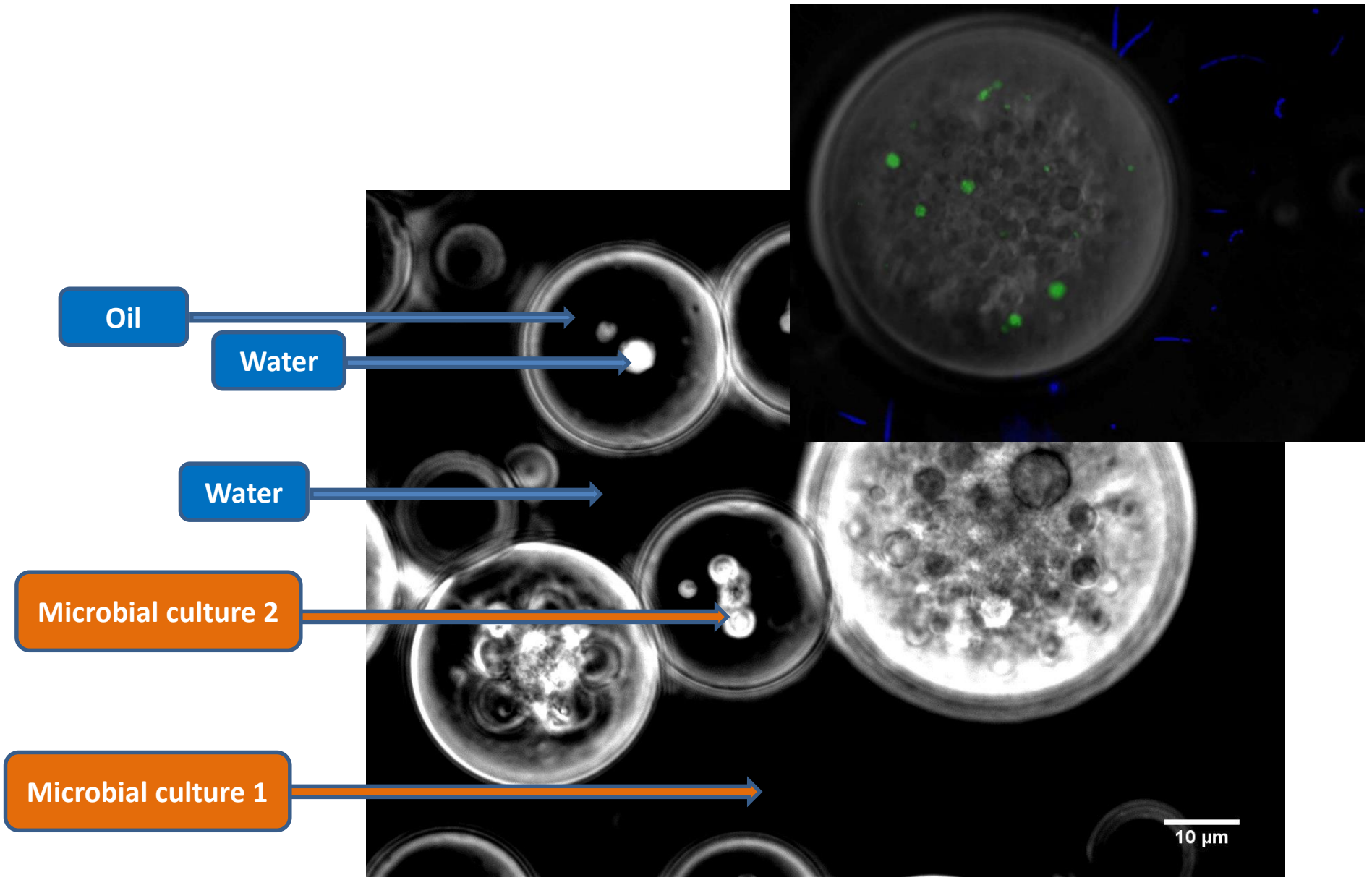
Double emulsions for microbiological control



Leaking OR *Release*?

RSC Advances

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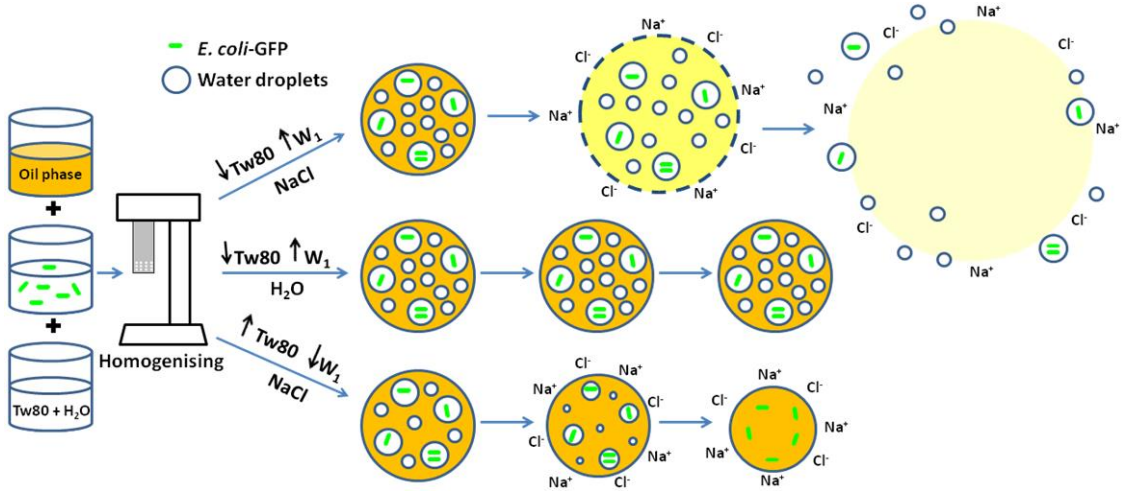
Understanding and controlling the release mechanism of *Escherichia coli* in double $W_1/O/W_2$ emulsion globules in the presence of NaCl in the W_2 phase†

Hani El Kadri,[a] Tim Overton,[ab] Serafim Bakalis[a] and Konstantinos Gkatzionis*[ab]



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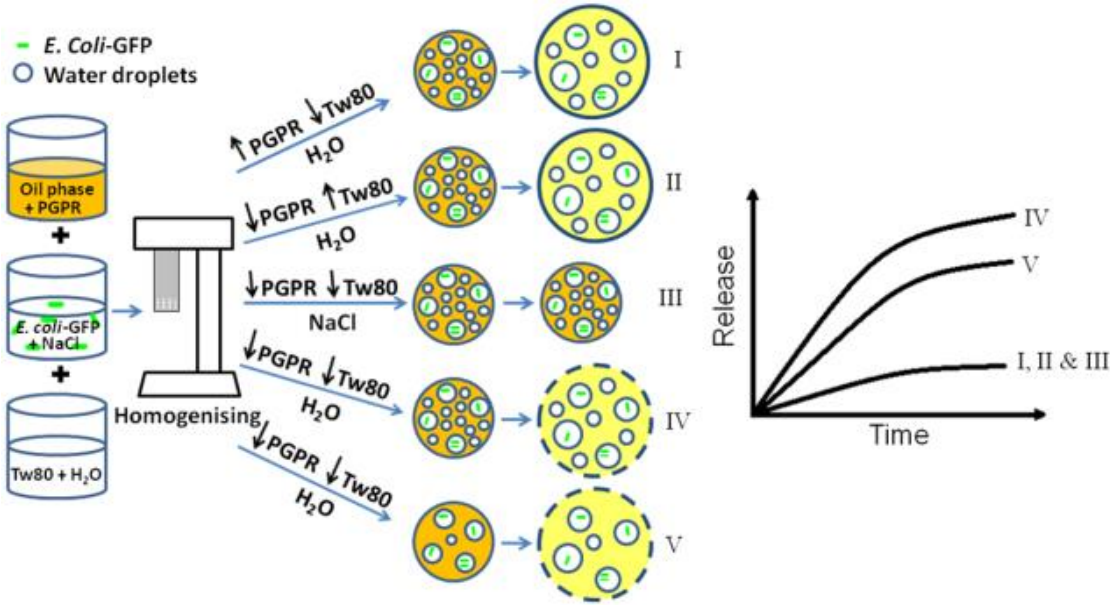
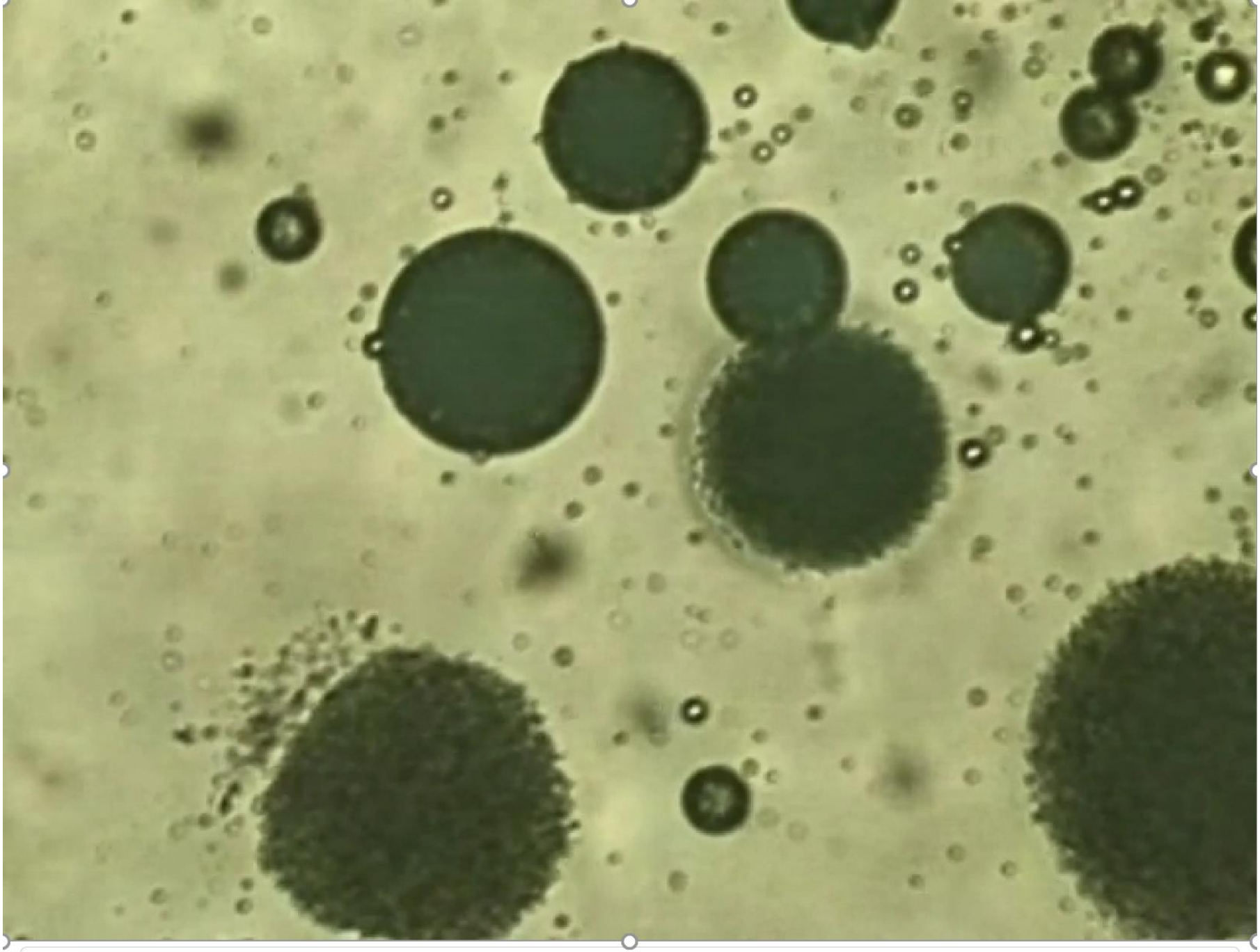
Modulating the release of *Escherichia coli* in double $W_1/O/W_2$ emulsion globules under hypo-osmotic pressure†

Hani EL Kadri,[a] Ramazan Gun,[a] Tim W. Overton,[ab] Serafim Bakalis[a] and Konstantinos Gkatzionis*[ab]

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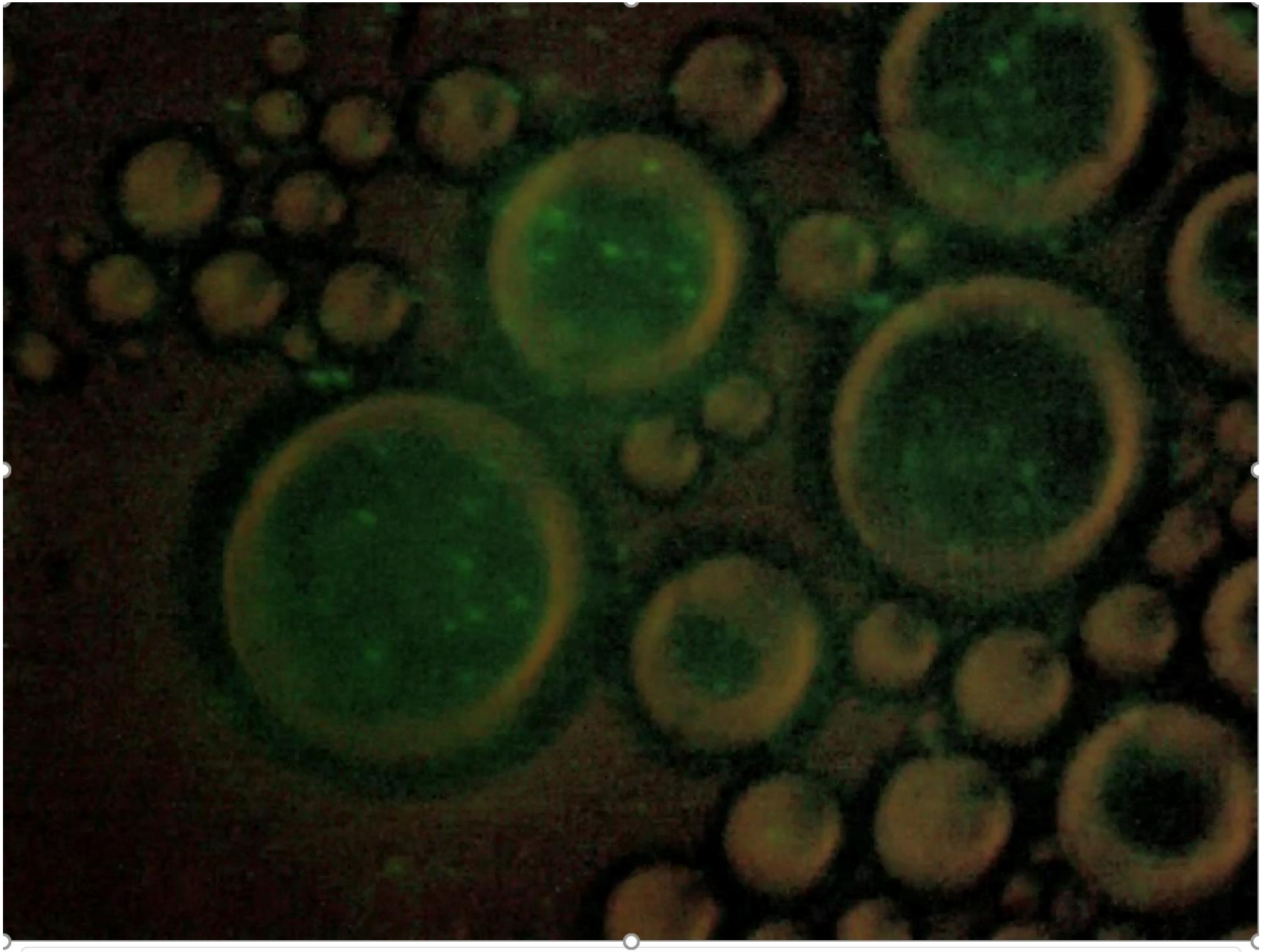
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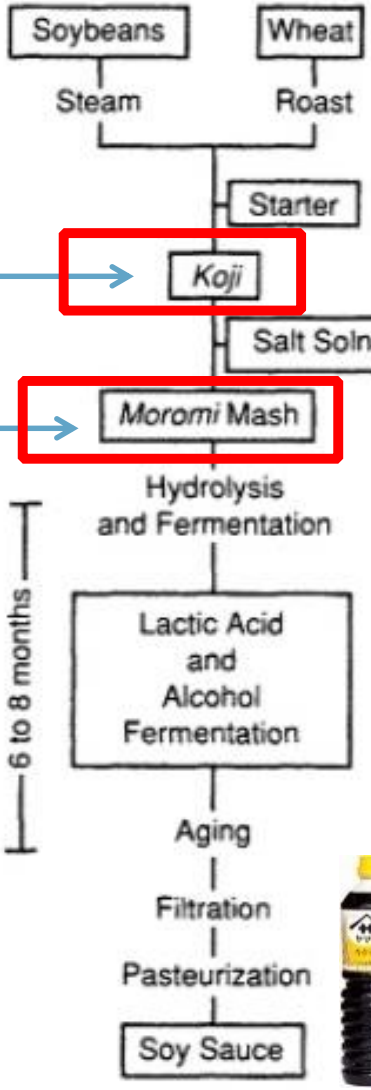
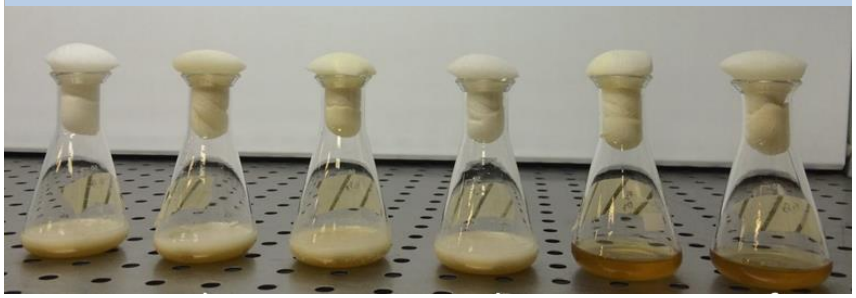
Soy production

Conventional Method



Moromi production model system



Mould spores: Aspergillus oryzae

+ 2.5 volume 20% NaCl

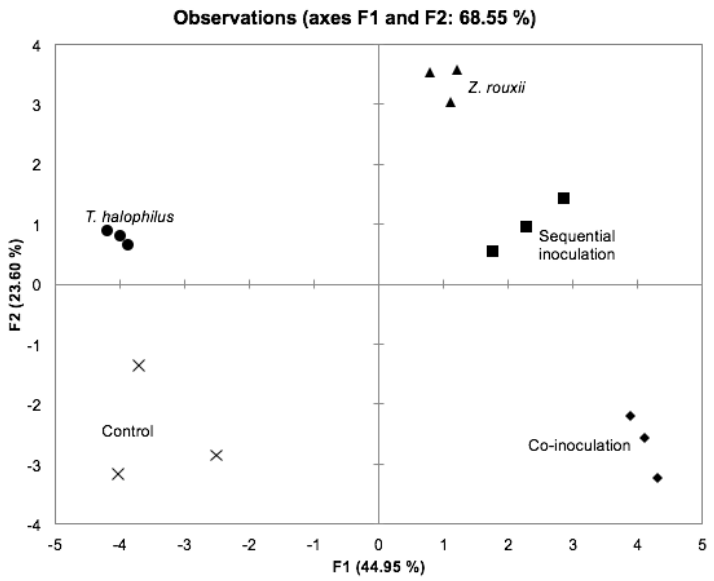
Salt-tolerant lactic acid bacteria

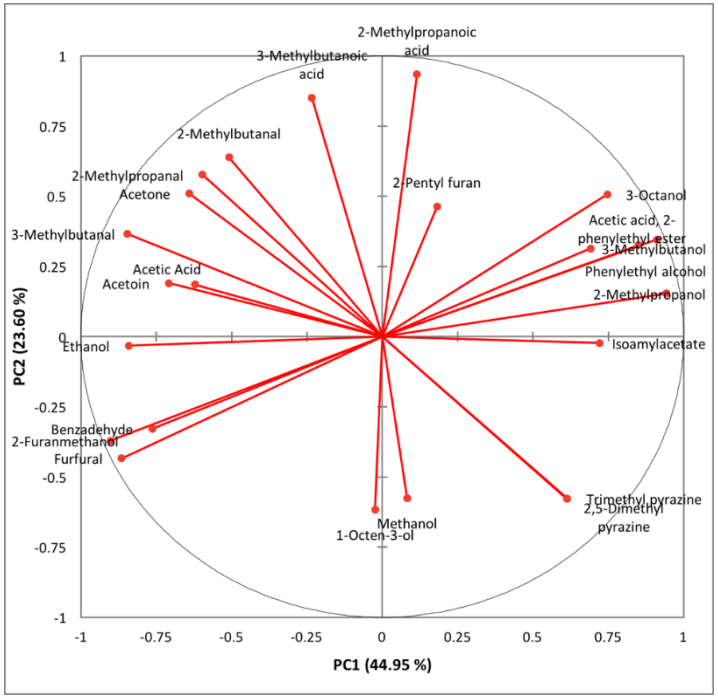
Natural fermentation : Many…but always … *Tetragenococcus halophillus*

Yeasts

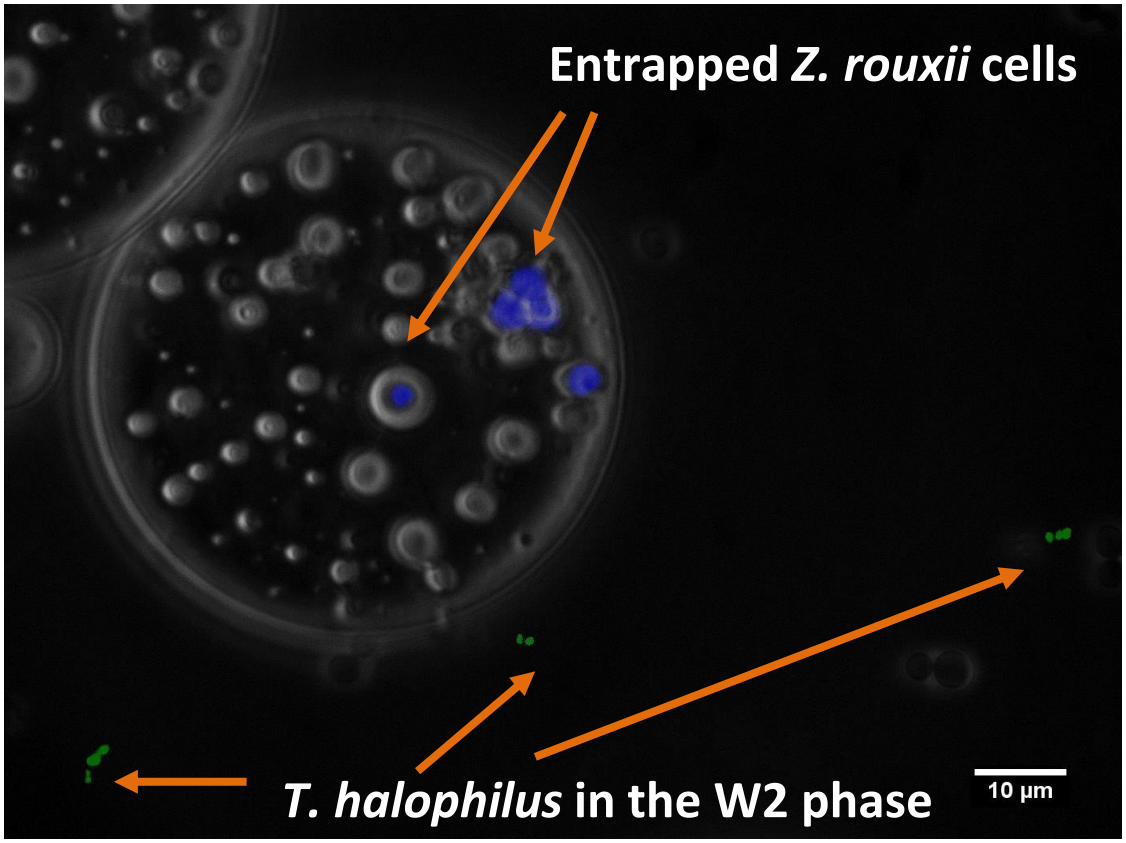
Many…but always …*Zygosaccharomyces rouxii*

Aroma production in soy sauce model system



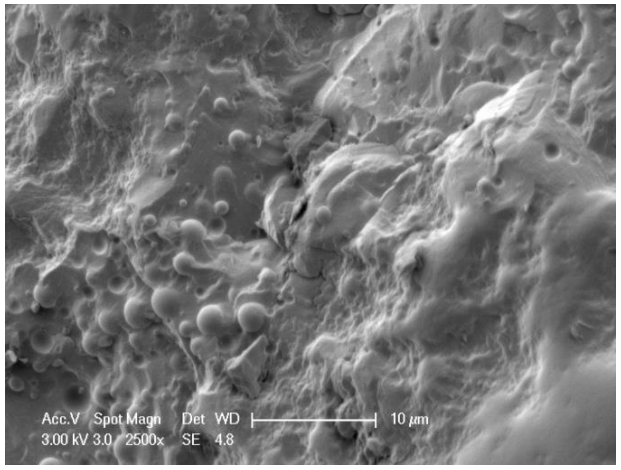


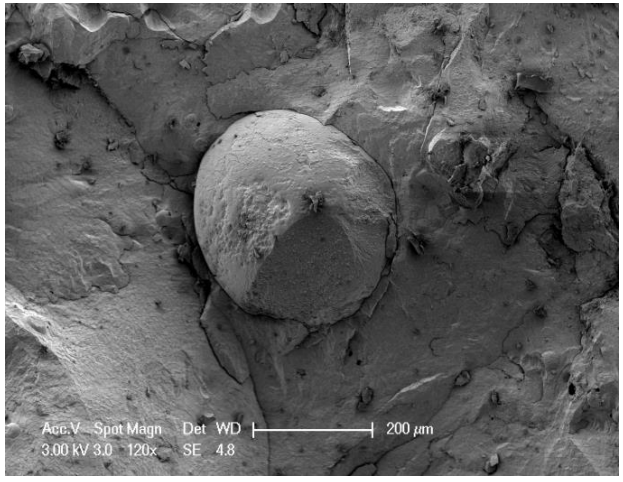
PCA of five moromi samples and aroma compounds after 30-days

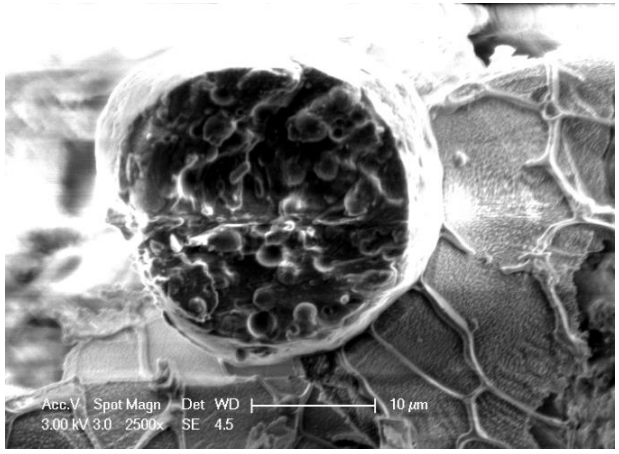


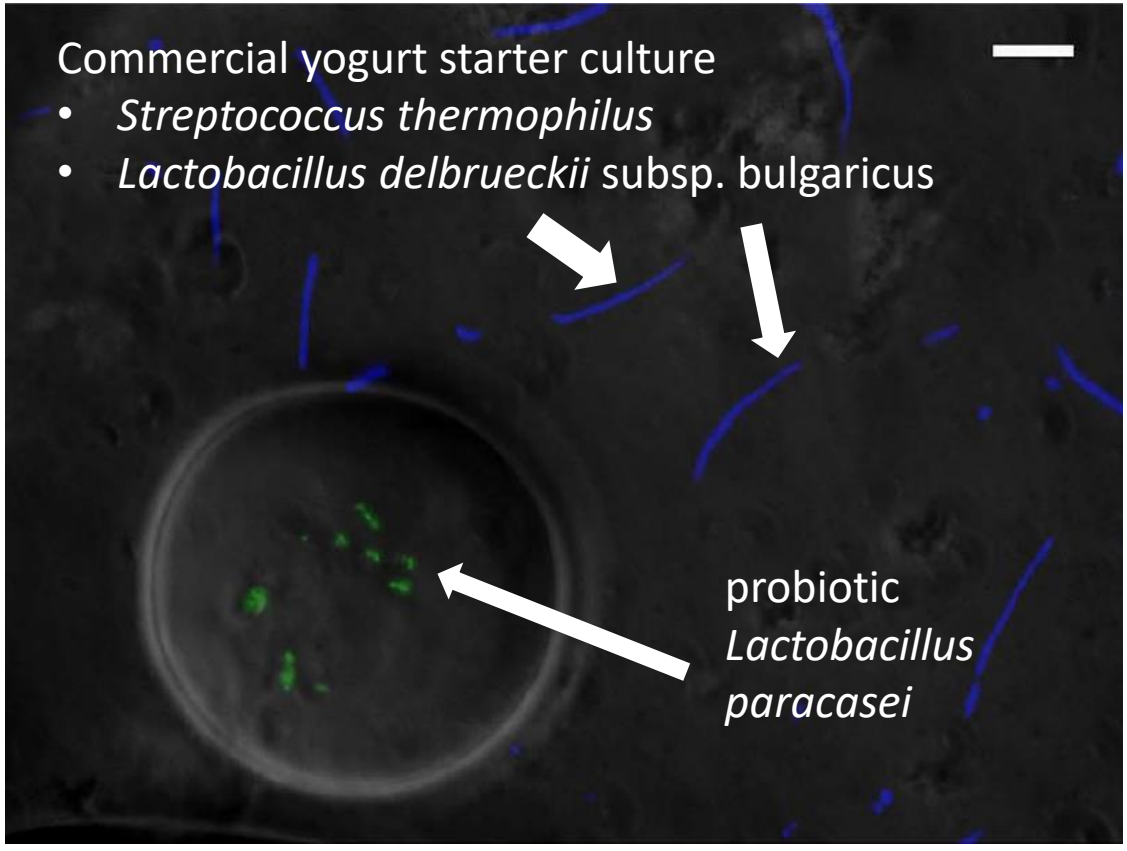
…. antagonism was observed as T. halophilus only proliferated (3 log increase) in the presence of Z. rouxii, while Z. rouxii growth was suppressed by 4 log in concurrence with pH increase to 7.31

Food Chemistry
Effects of co-inoculation and sequential inoculation of *Tetragenococcus halophilus* and *Zygosaccharomyces rouxii* on soy sauce fermentation









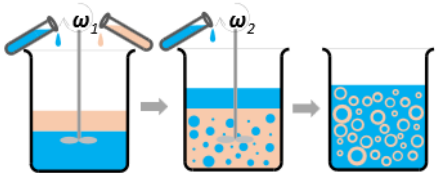

Food Research International

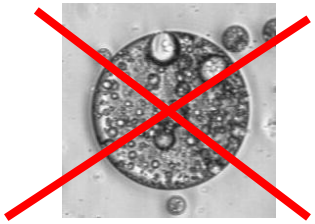
Incorporation of water-in-oil-in-water ($W_1/O/W_2$) double emulsion in a set-type yogurt model

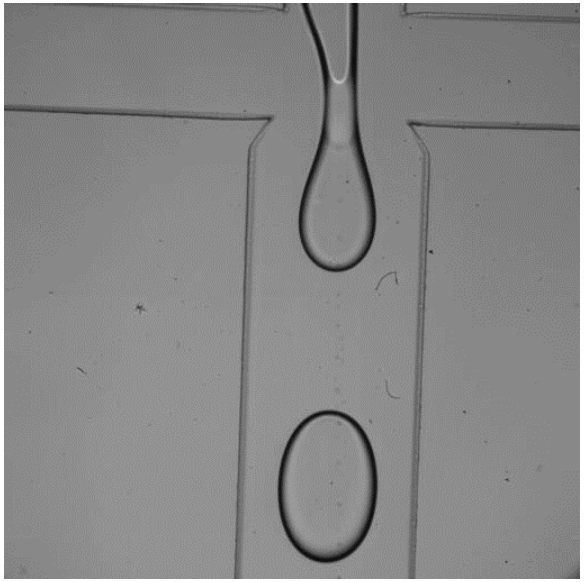

Food Research International

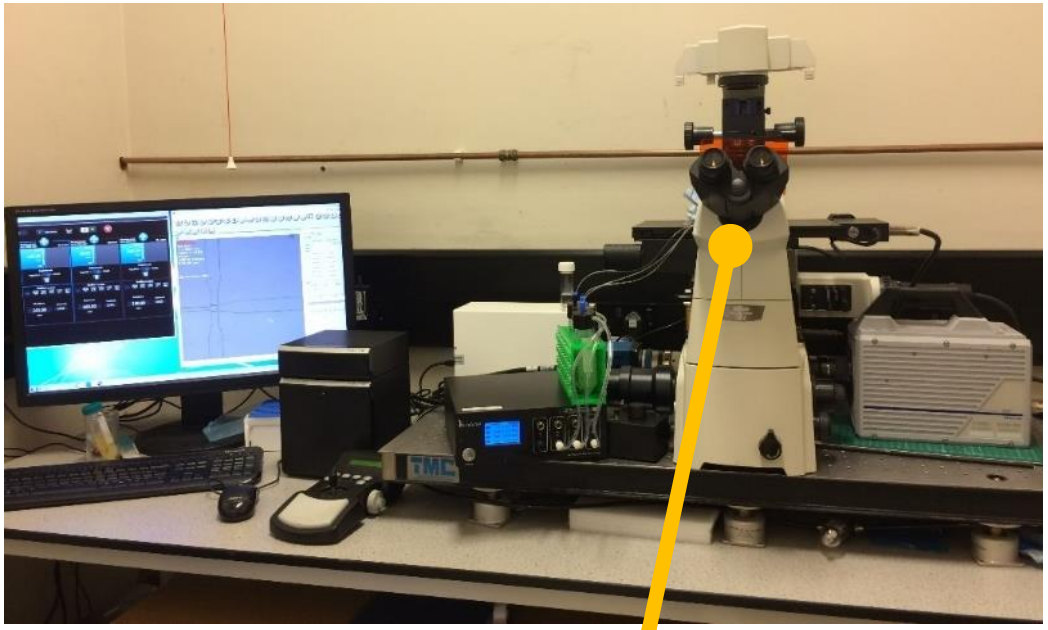
Utilisation of water-in-oil-water ($W_1/O/W_2$) double emulsion in a set-type yogurt model for the delivery of probiotic *Lactobacillus paracasei*

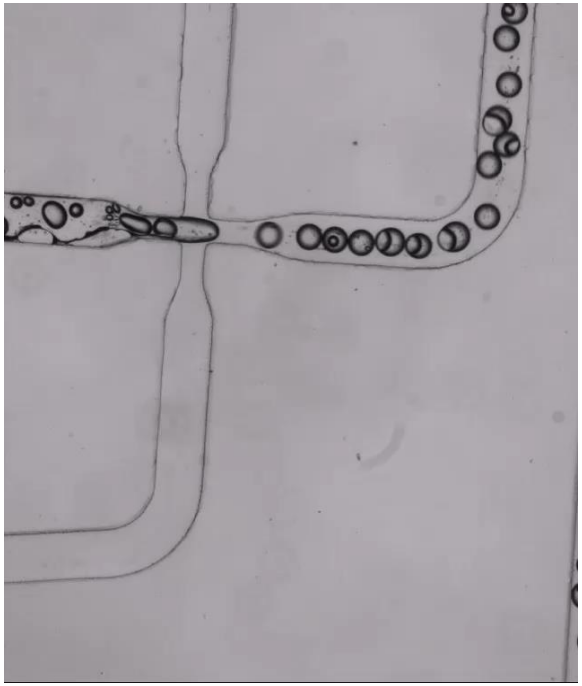
Microfluidics and $W_1/O/W_2$ double emulsion with microbes

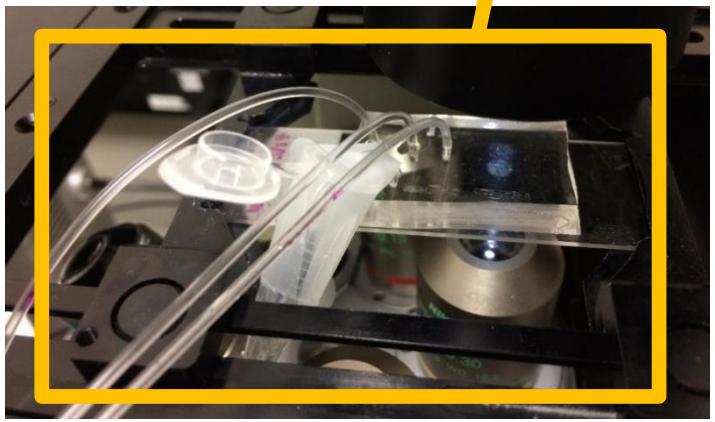




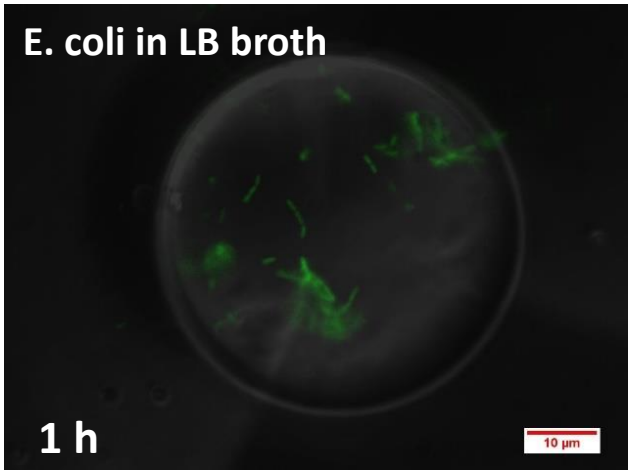


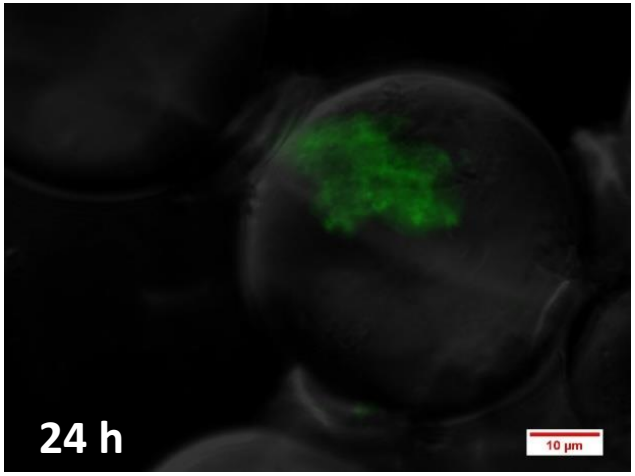


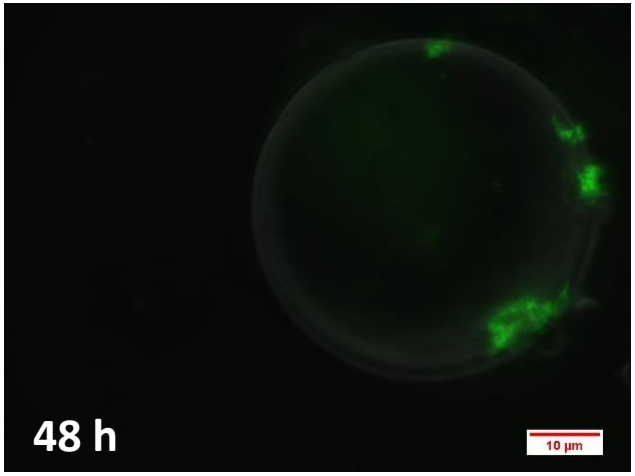




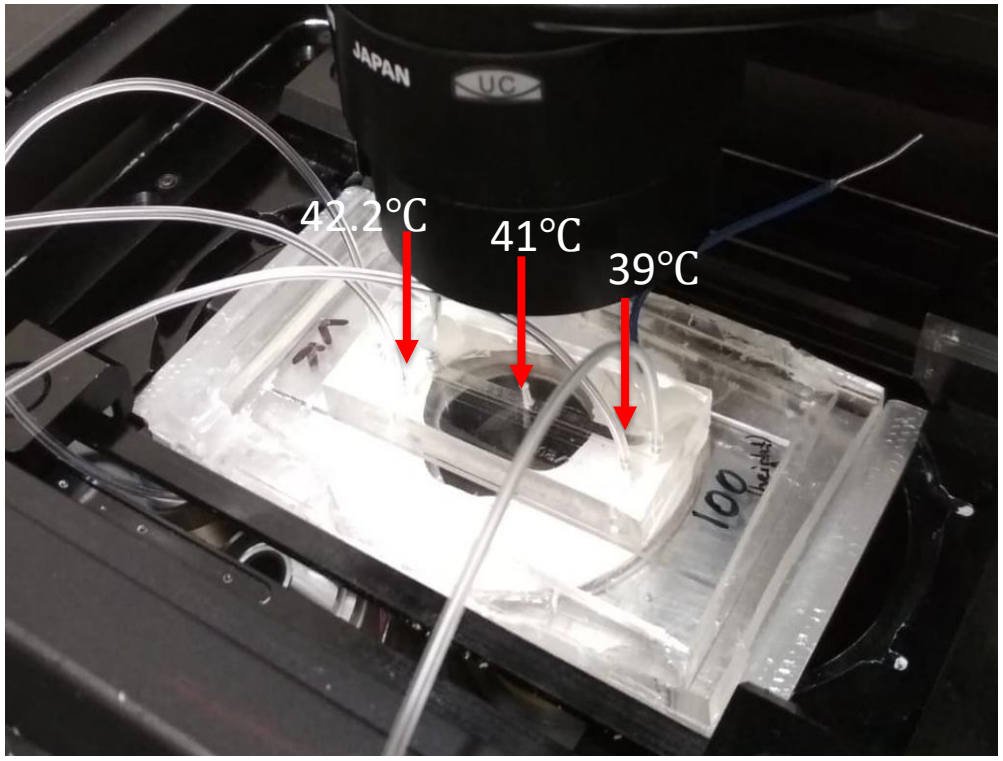
with Dr Daniele Vigolo, School of Chemical Engineering, UoB







Chips with thermal control intergraded – with Dr Daniele Vigolo, School of Chemical Engineering



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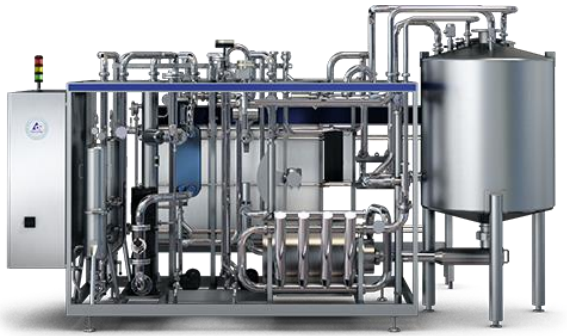
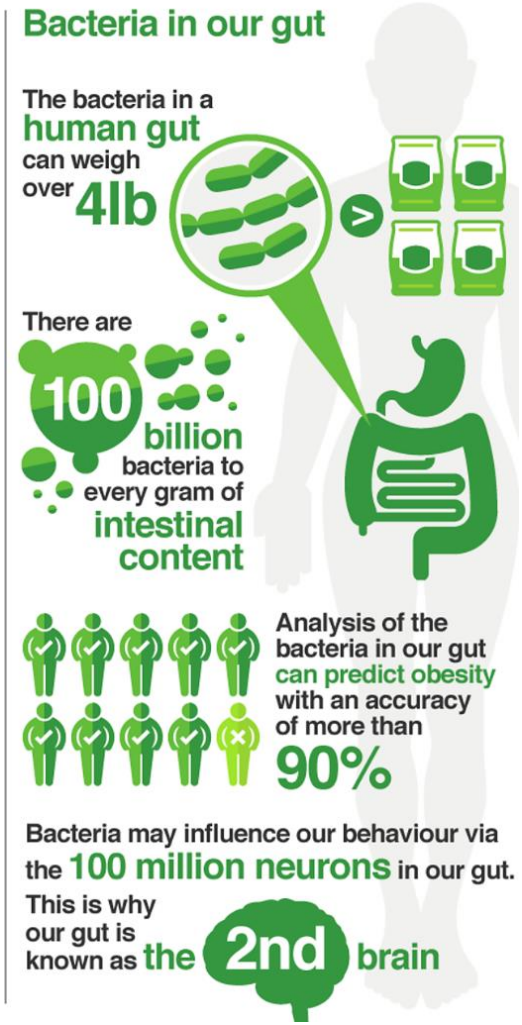


Microbes as part of food intake – interactions beyond food



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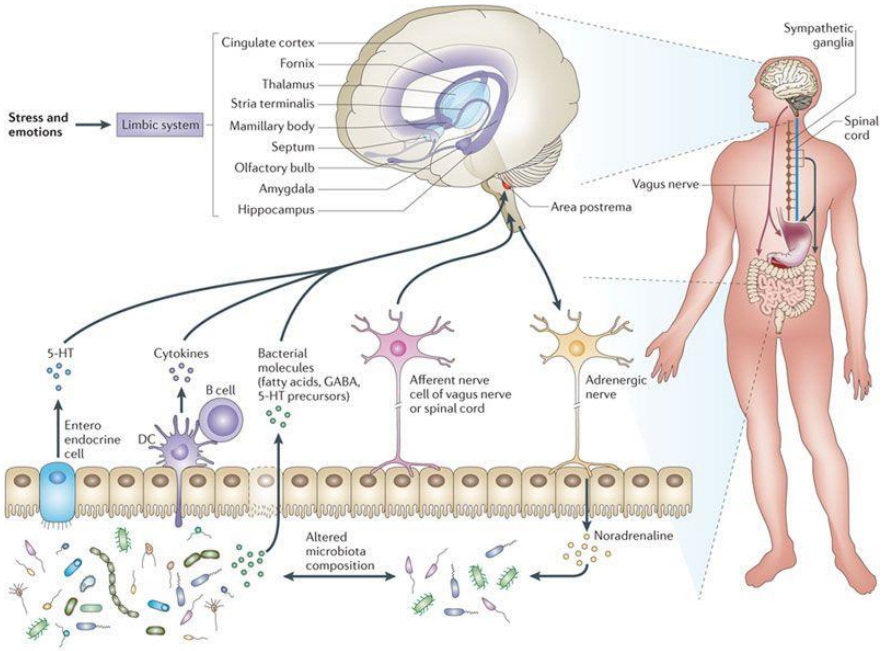
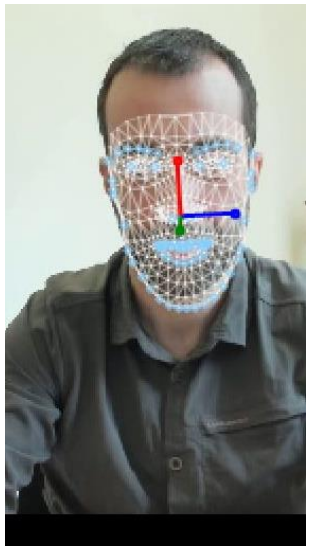
Stephen M. Collins, Michael Surette & Premysl Bercik

Nature Reviews Microbiology **10**, 735–742 (2012) | Download Citation



Nature Reviews | Microbiology

- The demand for fermented food will grow and opportunities for innovation too.
- Need for tailored food formulation and structure to facilitate complex microbiology.
- New claims like ***'% of microbes or fermented food'*** in final products may become part of branding… similar to '***0 trans***', '***fair trade***', '***low salt***' etc.
- ***Microbial composition*** of food may become part of labelling, like *sugar*, *protein*, *water* content etc.
- There will be need to link (i) food fermentation, (ii) resulting physicochemical properties of food and (iii) consumer responses and perception



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