

Would a breakthrough cheese technology be accepted by the consumer?

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#ADSA2023

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Would a breakthrough cheese technology be accepted by the consumer?

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www6.rennes.inrae.fr/stlo www6.rennes.inrae.fr/plateforme_lait Reseau de recherche pour l'innovation alimentaire

> Outline





Because <u>the context</u> is evolving constantly ... and we have to adapt

Resources are limited

... Cheese processing is energy and water-intensive and pollutes

Energy, water and pollution

- Scarcity of <u>resources</u> and ... a rise in prices
- <u>Water</u> scarcity: -15% of renewable water resources in France in 20 years
- **Growing greenhouse gas** (55.6 Gt CO₂ eq in 2020, **+ 55%** between 1990 and 2019)

Prices	∆ (2021%2020)		
Electricity	+6.6%		
Gas	+33.2%		
Oil	+21%		



	Cheeses		
Needs in Energy	4.9 – 8.9 MJ/kg cheese		
Needs in fresh water	1.2 – 3.8 l/l milk		
Kg eq CO₂/ Kg cheese	~ 1 [0.6 Fresh – 1.2 Hard]		
Wastewater	0.9+/- 0.5 l/l milk		
Whey	90% of the milk		





Because the context is evolving constantly ... and we have to adapt

Demand: (urban) **population growth** and... (9,8 B 2050) **People will continue to eat cheeses in the next decade**

- 1/3 of the milk converted into cheese at a global scale (2022 = 23 Millions T)
 - Especially in emerging countries/less in developed countries



	FAO Perspectives	2022	2031	Δ (%/γ
	World cheese consumption (kT)	25500	28136	+1,15%
	Developed countries consumption (kT)	19806	21393	+0,9%
	Emerging countries consumption (kT)	5694	6743	+2%

<u>But</u>: uses evolved, ... are evolving and will continue to evolve</u>

 <u>Shift</u> from cheese board to ingredients with functional properties: More than 55% in France and > 80% in emerging countries sliceability, shreddability, meltability, stretchability, ...





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Cheeses must be adapted to their new uses: functionals/new textures - Flavours



Obesity and related deseases ... Because the context is evolving constantly ... and we have to adapt Growing obesity in France by age 1997 2009 2020 Obesity French National Institute of Health and Inserm 18-24 years old 2.1% 4.0% 9.2% **Medical Research** NUTRI-SCORE 35-44 years old 7.7% 13.9% 16.7% 17.9% 19.9% >65 years old 11.2% Cheeses must be healthier less: fat, salt and with: microorganisms, probiotics A lot of expectations and specifications to solve for designing new products

But: <u>new knowledge</u> allows us to adapt to new needs and constraints:

* Metagenomic/meta-transcriptomic methods are effective to understand new routes for producing molecules of interest for taste and health (vitamins)

* **Decoupling** technological parameters permits to improve process efficiency/new uses

• How can we innovate in cheese technology?

Example of an innovative process by decoupling texture and flavour: GARRIC and al WO 2016/108024



> A large range of texture: by controling...

- LLOYD texture meter TA +: 50 N force applied on a 1 cm diameter disk
- Firmness defined as the max force reached at the first displacement of the probe





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> Designing the flavour bases

4 microbial species

Semi hard cheese





Blind test



Culture

- Optimized growth conditions (substrates, T°, pH, O₂, time...)
- Production of key flavour compounds

Descriptors and flavours

Molecules

Diacetyl

- Sulfur compounds
- Branched-chain alcohols
- Short-chain fatty acids
- Methyl ketones
- Branched-chain aldehydes
- Propionic acid

Sensory analysis

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- Panel of experts, 12 judges
- 5 points rating scale

GC-MS analysis

off flavour compounds

Types and doses of MO => mimic existing cheeses or to create new flavours/complex-strong

• Would a breakthrough cheese technology be accepted by the consumer?

MARTIN and al, Food Quality and Preference - 2023

 <u>The objective</u> of the work was to study the reaction of consumers to a radically new manufacturing process applied to a traditional product like Camembert.



Mild flavoured New Cheese (MFNC) => buttery notes (From'Innov process)

Typical Flavoured New Cheese (TFNC) => copying a Camembert (From'Innov process)



Acceptability of a sustainable technological innovation applied to traditional soft cheese: Information concerning the benefits for health and the environment can compensate for a lower hedonic appreciation

> <u>Method</u>: a traditional cheese and two cheeses resulting from a new sustainable process were <u>evaluated by 142 consumers</u> (compared acceptability)





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2 2

Method: 5 stages

1. Blind test \implies First evaluation : 1. the subjects were asked to rate how much they liked each cheese on a 10- points linear scale



Overall liking score for the 3 cheeses obtained using an unstructured linear scale, ranging **from** *"I don't like it at all"* (left end, score = **0**) **to** *"I really like it"* (right end, score = **10**).





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1. Blind test \rightarrow **2.** the subjects had to give their Willingness To Pay (WTP) for each cheese using a multiprice list WTP (1)





2. Blind test ⇒ The subjects were asked to successively taste the three cheeses and specify their level of satisfaction with the intensity of nine sensory properties → with a Just About Right scale: JAR ⇒ penalty analysis



Penalty analysis: Percentage of responses on the x-axis and the penalty scores on the y-axis (mean drops). In red, the properties perceived as too intense / present. In blue, properties perceived as not intense / present enough. In grey, the sensory properties for which the response percentage is too low to conclude (< 25% of the panel).

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3. Information: we then gave subjects information about **the manufacturing processes** of the three cheeses, **the subjects** had to give their **WTP**: **WTP2**

"A <u>new manufacturing process</u> has been developed by INRAE. It makes it possible to obtain cheeses by following a manufacturing process different from the <u>traditional</u> process. Compared to the traditional cheese-making process (coagulation, draining, salting then ripening), the new process **reorganizes and optimizes the manufacturing phases** (draining, salting, ripening and coagulation). The optimization of the stages makes it possible to obtain a finished product that can be consumed **10 days after manufacture, compared to 20 days** for a conventional process".

4/5. Information: The subjects received information concerning the advantages for the sustainability (Group 1) or health (Group 2) linked to the new cheese-making process and then had to give their WTP again: WTP 3 and WTP 4



CHAMBERLAND and al, Journal of Cleaner Production - 2019

Biochemical Δ NC/CC Mild F **Typical F** (%) characters NaCl % (m/m)1.21 - 22% 1.53 1.18 Fat % (m/m) 21.5 21 30 - 29% Dry Matter % (m/m) 50 44.6 44.2 - 11% Camg(m/m)429 539 + 20% 531

6. Questionnaire: We did a demographic profile and a short study of subjects' consumption of cheeses

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> Results

1. The CC cheese was preferred in the blind test and WTP 1 higher as a consequence



> Results

2. Information on the classic versus innovative process significantly increase the WTP gap:

Significantly due to the increase in Commercialized Cheese (**CC**) Non significantly due to the decrease in New Cheeses (NC)

3. However, information on health and sustainability (or the inverse) **narrowed the WTP gap significantly** Without significant differences in any order of information

4. Finally, the WTP for the 2 NC were not significantly different with the CC

Despite all the information (perceived negatively then positively) the final score for the 2 NC is significantly higher than the initial assessment, and equal for the **CC**



• Questions in progress

With the same methodology, we are continuing our investigations...

 <u>By testing</u> the effects of a lower NUTRISCORE (from D to C) and the addition of probiotics on subjects' WTP

We are able to decrease fat and salt to reach a **C NUTRISCORE** and add probiotics without bad acceptance

 <u>By testing</u> a semi hard cheese produce with the new technology with functionalities (meltability, stretchability, sliceability and shreddability) ... and new flavours on subjects' WTP (very challenging)

We are able to obtain a <u>better sustainability</u> with a shorter ripening and create new flavours



• Questions in progress

3. Then: How to adapt new products to market expectations



1. **to copy** or **to improve** existing products

The spyder diagram (JAR) permits us to understand how to modulate parameters to join market expectations

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2. to create new products:

"How to obtain aroma in solubilized soft cheese" by Marielle HAREL-OGER (as we did for the Typical flavoured camembert): very new!

Despite **the buffering capacity =>** (upcoming publication)







• Questions in progress

Finally... the next frontier will be:

Cheeses will continue to be traded ...

- **14%** of the world cheese production is traded
- +15% at a global scale 2015/2021 vs
 +29% 2021/2030 in China



CNIEL 2022 OECD-FAO 2022 Because the trade in cheese will go on and increase, we have patented this uncoupling technology by drying simultaneously or separately the texture matrix and flavour matrices (EP3240430A1).

We have now **to measure** by **Life Cycle Analysis** the **footprint of this technology** in comparison with the others.

 Because rehydrating cheese powder is convenient (in some countries without dairy sector), we develop new powders with functionalities and flavours for domestic or industrial uses









• Conclusion and perspectives

Next steps ?

Innovative cheesemaking concept

These results show that:

There is no major opposition to the application of technological innovations to traditional products such as <u>cheese</u>

and: for a new technology information concerning health and sustainability is positively accepted







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- 2. Can we adapt this technology to plant based product?
- 3. The last stage will be to understand if the dairy sector is ready to adopt such a technology: who could appropriate it and when? Major industries, SMI, farmers, artisans, ...



> Thank you for your attention

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For more information:





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