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Impact of a minimally processing route for the production of infant formulas on the organoleptic properties

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Introduction

Starting from the first month of their lives, many new-born babies are fed with industrial substitutes to breast milk. **Infant formulas** (IFs) are mainly composed of skimmed bovine milk with serum proteins, lactose, vitamins, minerals and lipids, which undergo heat treatments beforehand. These operations at high temperature insure **microbiological food safety**, but they also cause a formation of **Maillard reaction products** and a denaturation of **proteins**. These alterations affect nutritional and **organoleptic properties** of the IFs. Food quality is very important for most parents when purchasing, without taking the price into consideration. Increasing consumer interest towards breastfeeding and food naturalness has weakened the infant nutrition sector, pushing companies to **innovate** to respond to consumer requests and to face up to competition. **Microfiltration** could be an alternative to reduce the heat treatments for milk debacterisation. The aim of the study is to determine the IF minimally processed effects on the organoleptic properties.



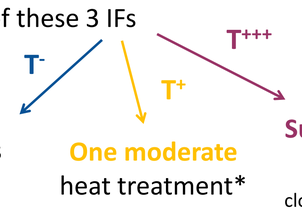
Methodology

Sampling preparations

> 3 **experimental** IFs manufactured at semi-industriel scale

- Fresh skimmed milk purified on a 0.8µm mineral membrane at 50°C
- Gradual addition of components
- Preparation of these 3 IFs





No heated treatments

One moderate heat treatment*

Successive & **higher** heat treatment close to industrial processes

> 2 **commercial** IFs on the current market* : the brands **B** and **G**

IFs preparations made according to the brand advice



*Only used for the sensory part

Sensory characterisation

> **Comparison** between the commercial and experimental IFs

- **Triangular tests**, to evaluate global sensory differences



A panel of 50 adults had to choose between 3 cups
— 2 with the same IF
10 IFs pairs presented to each panellist

Williams Latin Square for pair and triplet presentations

- **Check-All-That-Apply** method, to qualify generally each IF from a list of 20 descriptors
  — as colour, taste, texture and odour



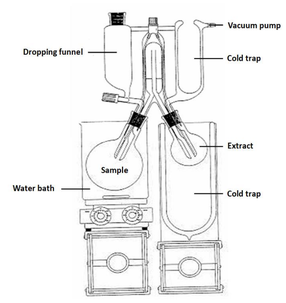
The 50 panellists tasted independently the 5 IFs, and then ticked as **many descriptors** as they thought **appropriate** to qualify each IF

- **Statistical analysis**

PCA on **quotation frequencies** of the descriptors in order to represent some disparities between the 5 IFs

Physico-chemical characterisation

> Characterisation of **volatile organic compounds** (VOCs) only in **T⁻** and **T⁺⁺⁺**



Solvent Assisted Flavour Evaporation (SAFE)



Analysis by GC-MS

7890A Agilent GC with a DB-WAX column (30m*0.25mm*0.50µm); 1µL injected; helium as carrier gas (40cm/s); 40°C to 240°C (10min) with a rate of 4°C/min.
5975C Agilent MS: electronic ionisation and quadrupole

- Extraction of the VOCs by SAFE (2.10^{-2} mbar, 35°C, 90 min)
- Extraction of the water-based phase with CH_2Cl_2
- Concentration of the organic phase in Kuderna Danish apparatus
- 3 replicates of **T⁻** and **T⁺⁺⁺**

Results & discussion

Sensory characterisation

	B	T-	T+	T+++
G	30	35	32	31
B		31	38	32
T-			18	30
T+				19

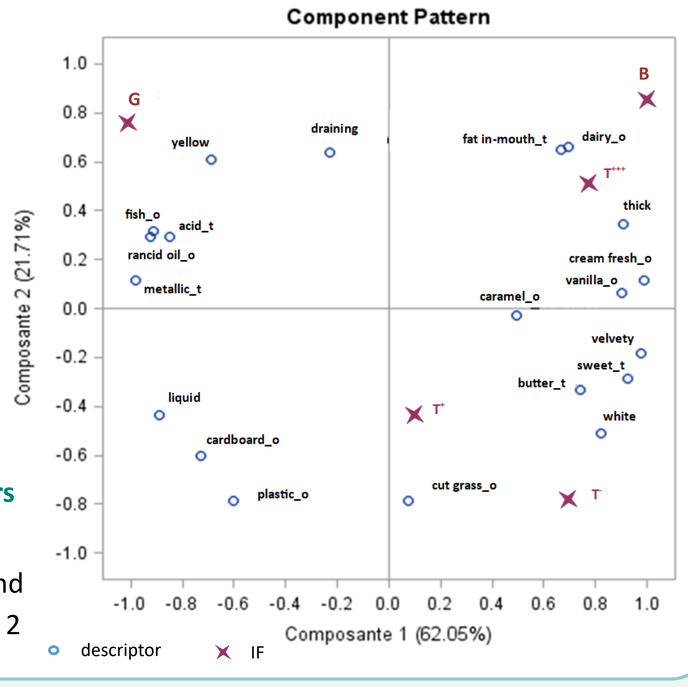
> The **triangular tests**

Significant differences if there is **more than 23 correct** answers ($p < 0.05$)
Significant differences between the experimental/commercial IFs, T^-/T^{+++} and the both commercial brands, according to the 50 panellists

> The **Check-All-That-Apply** method

The main descriptors used to qualify each IF by the 50 panellists
— among taste and odour

G	B	T-	T+	T+++
Fat in-mouth				
Cardboard	Dairy	Sweet	Sweet	Fat in-mouth
Rancid Oil	Sweet	Butter	Cardboard	Sweet
Dairy	Fat in-mouth	Fat in-mouth	Dairy	Dairy
Metallic				



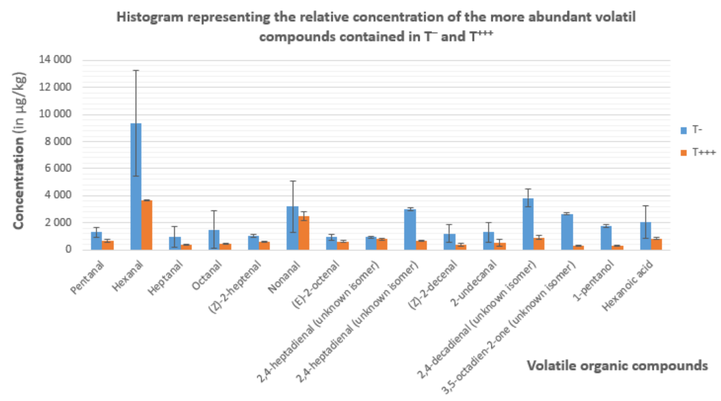
On the adjacent PCA :

. **Opposition** between the **off-flavour** and the **pleasant descriptors** (left and right respectively), according to the component 1

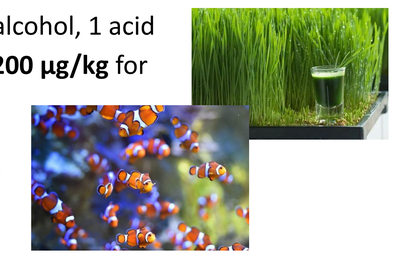
. **Distinction** of the brand G from other IFs; then of the brand B and **T⁺⁺⁺** on one side and **T⁻** and **T⁺** on the other side of the component 2

Physico-chemical characterisation

. Identification of **40 VOCs** with aldehydes, ketones, alcohols, acids... Same VOCs contained in **T⁻** and **T⁺⁺⁺**, but in various proportions



. More VOCs in **T⁻** than **T⁺⁺⁺**, in most of the cases
15 VOCs on 40 at a concentration **higher or close to 1,000 µg/kg**
whose 12 aldehydes, 1 ketone, 1 alcohol, 1 acid and an average concentration of **200 µg/kg** for **ketones** & **alcohols**



. **Grass**/green, **fat** in-mouth, fish as the main **odour descriptors**[1, 2]

Discussion

. VOCs profile is an **integrity indicator** of the IFs, especially following the evolution of a **simple** and **saturated** aldehydes group (pentanal, hexanal). **Peroxidation** of some unsaturated fatty acids drives to a formation of **hydroperoxydes**, whose decomposition takes to several secondary products[2, 3]—as aldehydes, ketones…

Chávez-Servín[3] studies the pentanal and hexanal concentrations on 20 IFs, during a storage of 70 days. After 30 days of storage, their concentrations in the experimental IFs are in the average of **120—12,500 µg/kg** for the **hexanal** and **380—4,530 µg/kg** for the **pentanal**.

. Sensory properties are essential for acceptability by infants and their parents. The 3 experimental IFs were described with "pleasant" descriptors. Moreover, the comparison with the 2 commercial IFs allows the experimental ones to be located within the current infant nutrition market. **T⁻**, **T⁺** and **T⁺⁺⁺** are close to the brand B and are in opposition to the brand G. The off-flavour descriptors —as fish, plastic—found with the VOCs characterisation were not systematically reported by the panellists.

Conclusion

The **microfiltration in IF industry** is a promising way to reduce the use of thermal treatments, while complying with the microbiologic safety. There is an **impact** on the organoleptic properties of the experimental IFs, in comparison to the commercial brands.
However, the panellists qualified T⁻ with "**pleasant**" **descriptors**. T⁻ can have its place in the infant nutrition market.

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[2] Fenaille F. *et al.* (2003). *Comparison of mass spectrometry – based electronic nose and solid phase micro extraction gas chromatography – mass spectrometry technique to assess infant formula oxidation*. **Journal of Agricultural and Food Chemistry**, 51, 9, 2790 – 2796.
[3] Chávez-Servín J.L. *et al.* (2008). *Volatile compounds and fatty acid profiles in commercial milk-based infant formulae by static headspace gas chromatography: Evolution after opening the packet*. **Food Chemistry**, 107, 558-569.