Protein ingredient quality within infnat formulas impacts digestion and amino acid bioavailability: a combined in vitro and in vivo approach

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Abstract #: 1396T

INTRODUCTION AND OBJECTIVES

- ✓ **Infant formula** (IF) is the only adequate substitute to **Human milk** (HM) even though **differences of fine composition** and **structure are still remaining**.
- ✓ **IF** is a **complex matrix** that require **numerous ingredients** and **processing steps**.
- ✓ **Protein ingredients quality differs** depending on their **origin** (whey *vs.* ideal whey) and

➔ The present study aimed to **evaluate how protein ingredient quality** (structure and composition) **within IF modulates its structure, digestive kinetics** and **plasma amino acid** (AA) **content**

MATERIALS AND METHODS

SEMI-INDUSTRIAL PRODUCTION OF 4 IFs (A/B/C/D)

- **Ingredients: Commercial whey proteins (WPs) ingredients** with **different origin** (cheese : IFs-A & -B *vs.* ideal whey IFs-C & -D) and **structure. Casein with different supramolecular organization** (micellar : IFs-A, -B & -C *vs.* non micellar IF-D)
- **Processing: Same processing route**, representative of industrial methods

DIDGI® system

IN VITRO DYNAMIC DIGESTION

(Chauvet *et al.*, 2023)

Model of a 4-week old infant

- Sampling time: diet (G0), gastric phase (G20, G40, G80, G120, G180), intestinal phase (I20, I40, I80, I120, I180)

(Ménard *et al.*, 2015; De Oliveira *et al.*, 2016)

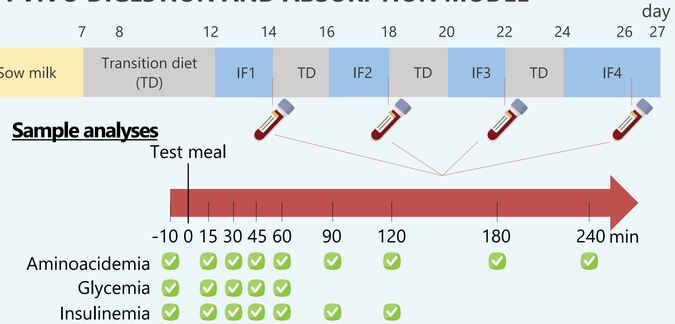
MACROSCOPIC → MICROSCOPIC SCALE

Evolution of the matrix structure
- Laser light scattering
- Confocal microscopy

Proteolysis
- SDS-PAGE
- LC-MS/MS
- OPA
- Ion-exchange chromatography

IN VIVO DIGESTION AND ABSORPTION MODEL

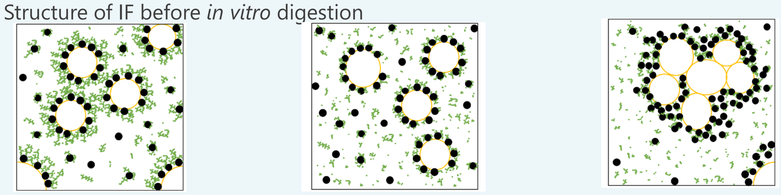
10 Yucatan mini-piglets
7 to 27-days old



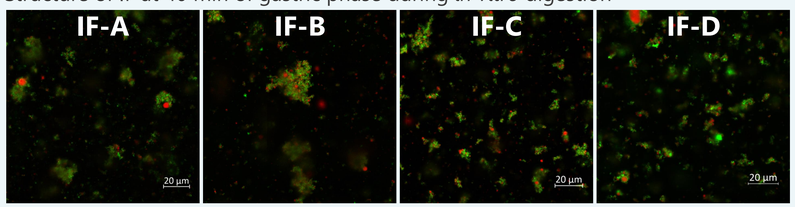
RESULTS

STRUCTURE BEFORE AND DURING *IN VITRO* DIGESTION

Structure of IF before *in vitro* digestion



Structure of IF at 40 min of gastric phase during *in vitro* digestion



Structure highlights before digestion :

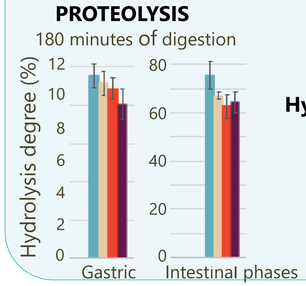
- **IF A** = **denatured WPs aggregated** at the interface of casein micelles, themselves **adsorbed at the surface of fat droplets.**
- **IF B & C** = **mixture** of both **native an denatured/aggregated WPs** in the soluble phase, and with **caseins adsorbed at the surface of fat droplets.**
- **IF D** = **large aggregates of fat droplets, denatured/aggregated WPS and caseins**

Structure highlights during *in vitro* digestion :

- Aggregates size → **IFs-A/-B > IF-C > IF-D**
- Aggregates size differences were directly related to the proteolysis of κ-casein by pepsin which led to the rapid aggregation of caseins and fats droplets

PROTEOLYSIS

180 minutes of digestion



Hydrolysis degree :

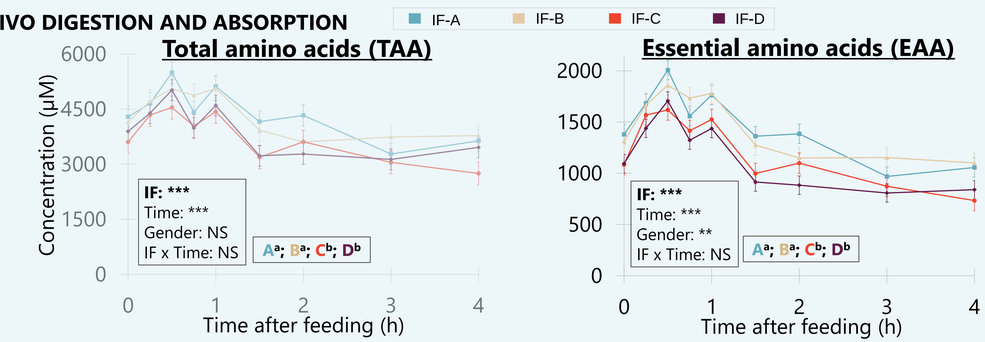
- IF-A > IF-D at the end of **gastric** and **intestinal phases**
- IF-A > IF-C at the end of **intestinal phase**

Peptide release kinetics :

- More **abundant release of casein-derived** peptides **at 80 min of gastric phase in IF-D** digesta than in other IFs digestas → Related to the **difference in casein supramolecular organization**
- **More abundant and late release** (intestinal phase) of **α-lactalbumin and β-lactoglobulin derived peptides** in digestas of **IFs-C and –D** than in digestas of IFs-A and –B → related to the **higher level of native WPs** in IFs-C and –D.

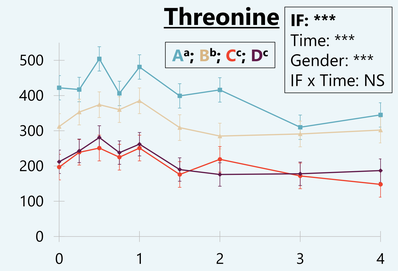
Chauvet *et al., 2023*

IN VIVO DIGESTION AND ABSORPTION



Plasma TAA concentrations : IFs-A & -B > IFs-C (+17%) & –D (+12%) at both **preprandial** and **postprandial times**.

Plasma TAA differences are mainly due to the plasma EAA concentrations : IFs-A & -B > IFs-C (+20%) and -D (+26%)



↑ **dietary Thr** level (IFs-A and -B) + **limited Thr degradation enzyme capability** in piglets **= modification of Thr homeostasis**

Modifications since preprandial time = **Modification of AA homeostasis**

↓

Rapid metabolic adaptation after a 2-day period of IF consumption.

Representation corrected by meal dilution and emptying (*Mean ± SEM;* NS, non significant; *, P<0.05; **, P<0.01; ***, P<0.001)

CONCLUSIONS & PERSPECTIVES

- ➥ **WPs denaturation and casein supramolecular organisation** impact the **emulsion microstructure** within IFs
- ➥ **Proteolysis** is **favoured** during *in vitro* dynamic digestion when **WPs are more denatured** and **peptide-release kinetics** are modulated by the **casein organisation**
- ➥ The **origin of the WP ingredients** (cheese *vs.* ideal whey) resulted in the main **differences** in plasma AA levels **due to the presence or not of GMP.**
- ➥ **Homeostasis of many AAs was modified after a short adaptation period** and most of the differences observed preprandially explained the differences observed postprandially.

THESE RESULTS HIGHLIGHT THE IMPORTANCE OF CONSIDERING THE QUALITY OF THE PROTEIN INGREDIENTS WHEN MANUFACTURING IFs

Chauvet L. *et al.* Protein ingredient quality of infant formulas impacts their structure dans kinetics of proteolysis under *in vitro* dynamic digestion. *Food Research International* (2023).
Bourlieu C. *et al.* Specificity of Infant Digestive Conditions: Some Clues for Developing Relevant In Vitro Models. *Crit Rev Food Sci Nutr* (2014).
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