



**HAL**  
open science

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

Lucile Chauvet, Yann Le Gouar, Olivia Ménard, Brunel Alexis, Marie-Françoise Cochet, Julien Jardin, Sylvie Guerin, Regis Janvier, Armelle Cahu, Thomas Croguennec, et al.

### ► To cite this version:

Lucile Chauvet, Yann Le Gouar, Olivia Ménard, Brunel Alexis, Marie-Françoise Cochet, et al.. Protein ingredient quality within infnat formulas impacts digestion and amino acid bioavailability: a combined in vitro and in vivo approach. ADSA annual meeting 2023, Jun 2023, Ottawa, Canada. , Journal of Dairy Science, 106 (supplement 1), pp.337-338, 2023, Abstracts of the 2023 American Dairy Science Association® Annual Meeting. hal-04155468

**HAL Id: hal-04155468**

**<https://hal.inrae.fr/hal-04155468v1>**

Submitted on 7 Jul 2023

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0 International License

# Protein ingredient quality within infant formulas impacts digestion and amino acid bioavailability: a combined *in vitro* and *in vivo* approach.

L. Chauvet<sup>1,2,3</sup>, Y. Le Gouar<sup>1</sup>, O. Menard<sup>1</sup>, M.-F. Cochet<sup>1</sup>, A. Brunel<sup>1</sup>, J. Jardin<sup>1</sup>, S. Guérin<sup>2</sup>, R. Janvier<sup>2</sup>, A. Cahu<sup>2</sup>, T. Croguennec<sup>1</sup>, M. Van Audenhaege<sup>3</sup>, D. Dupont<sup>1</sup>, I. Le Huërou-Luron<sup>2</sup>, M. Lemaire<sup>3</sup>, A. Deglaire<sup>1</sup>

<sup>1</sup>INRAE, Institut Agro, STLO, 35042 Rennes, France; <sup>2</sup>Institut NuMeCan, INRAE, INSERM, Univ Rennes, 35590 Saint Gilles, France; <sup>3</sup>Centre Recherche & Innovation, SODIAAL International, 35000 Rennes, France

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

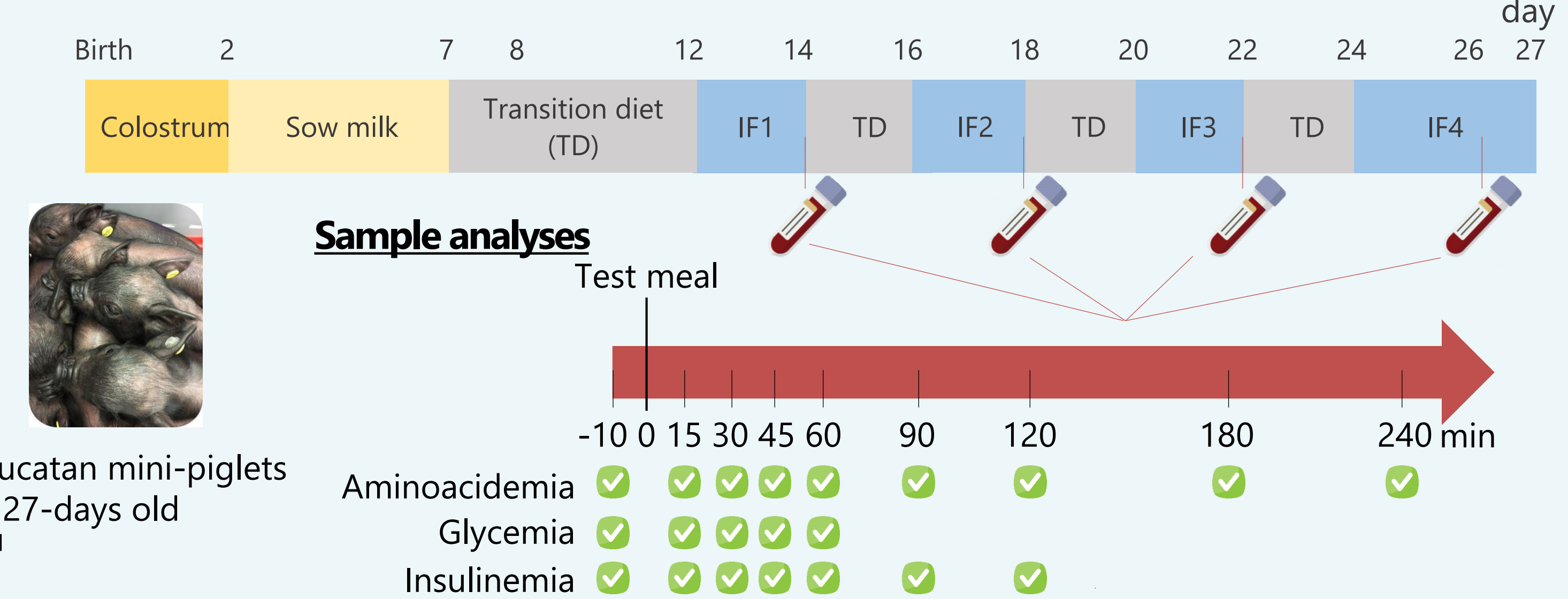
#### Evolution of the matrix structure

- Laser light scattering
- Confocal microscopy

#### Proteolysis

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

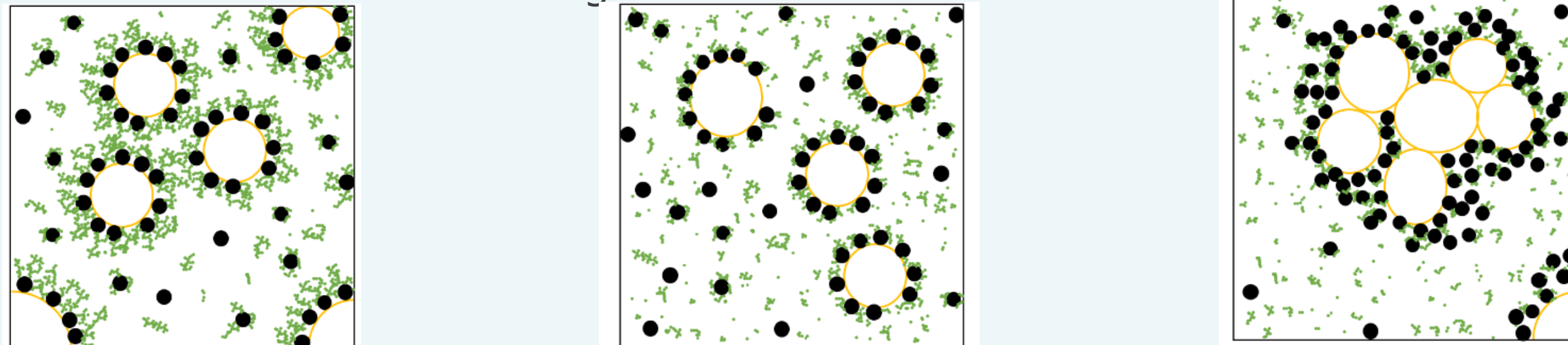
## IN VIVO DIGESTION AND ABSORPTION MODEL



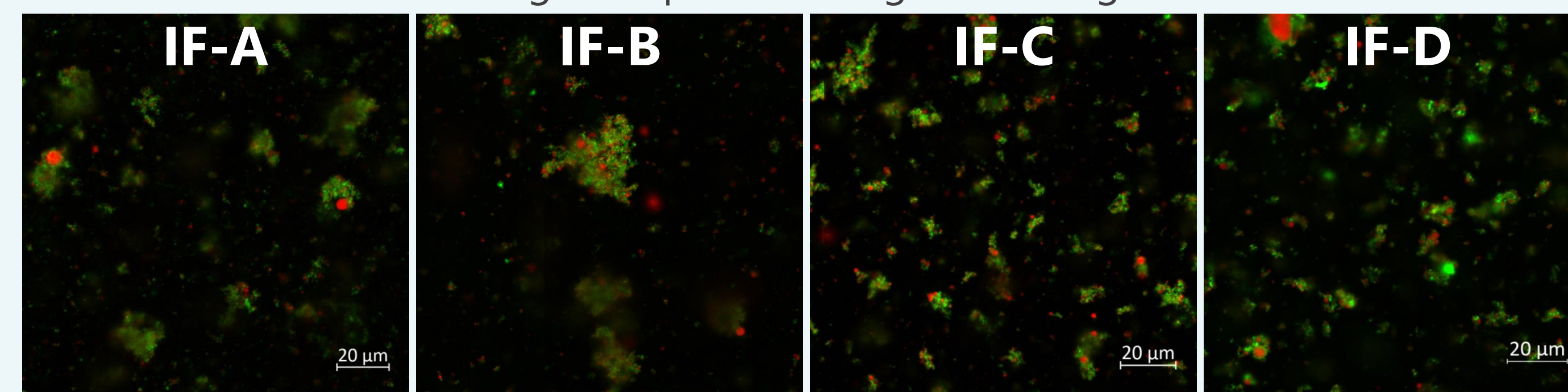
## RESULTS

### 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 and 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 :

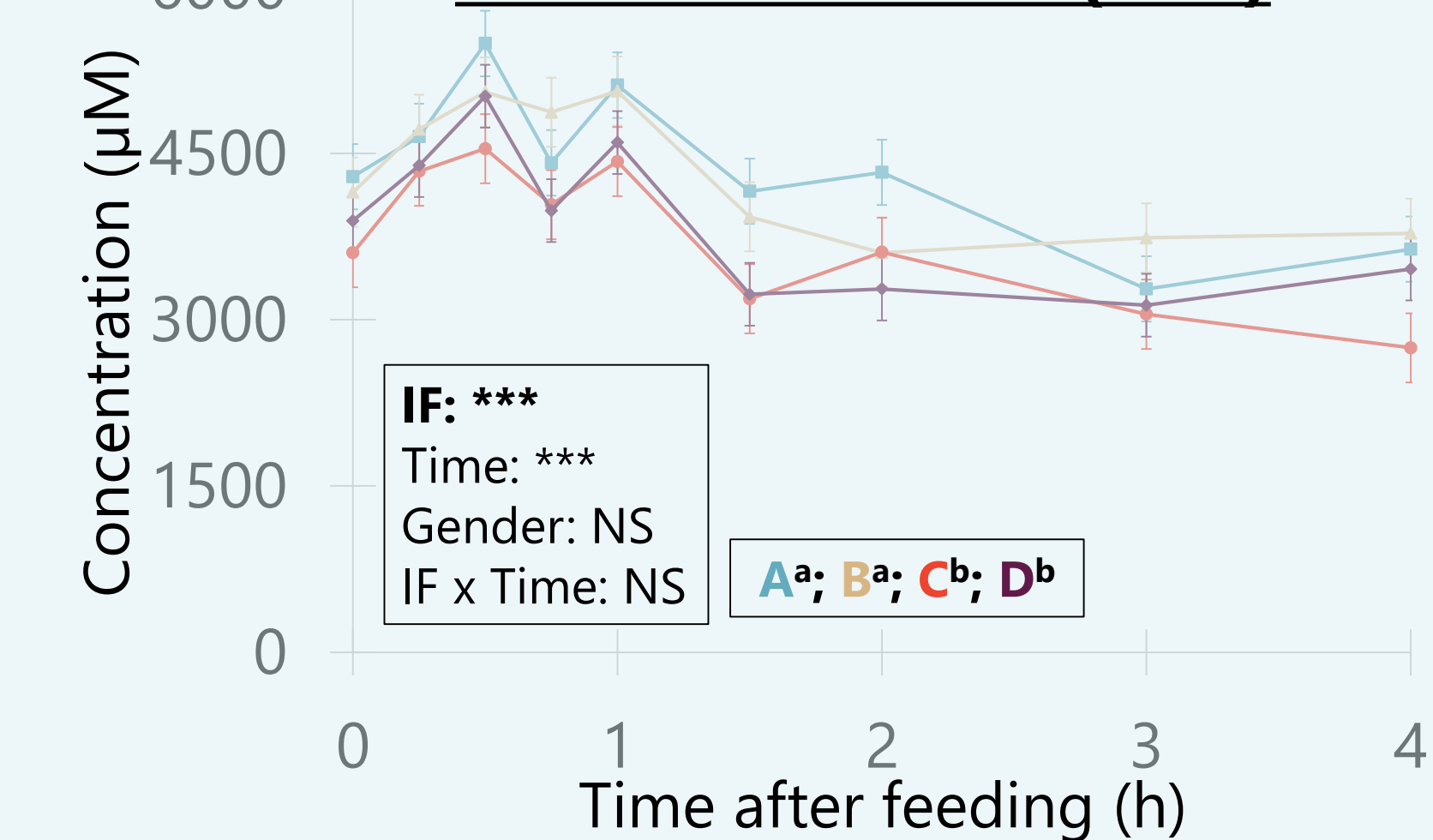
- **Aggregates size** → **IFs-A/-B > IF-C > IF-D**
- **Aggregates size differences** were directly related to the **proteolysis of κ-casein by pepsin** which led to the **rapid aggregation of caseins and fats droplets**

#### 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)

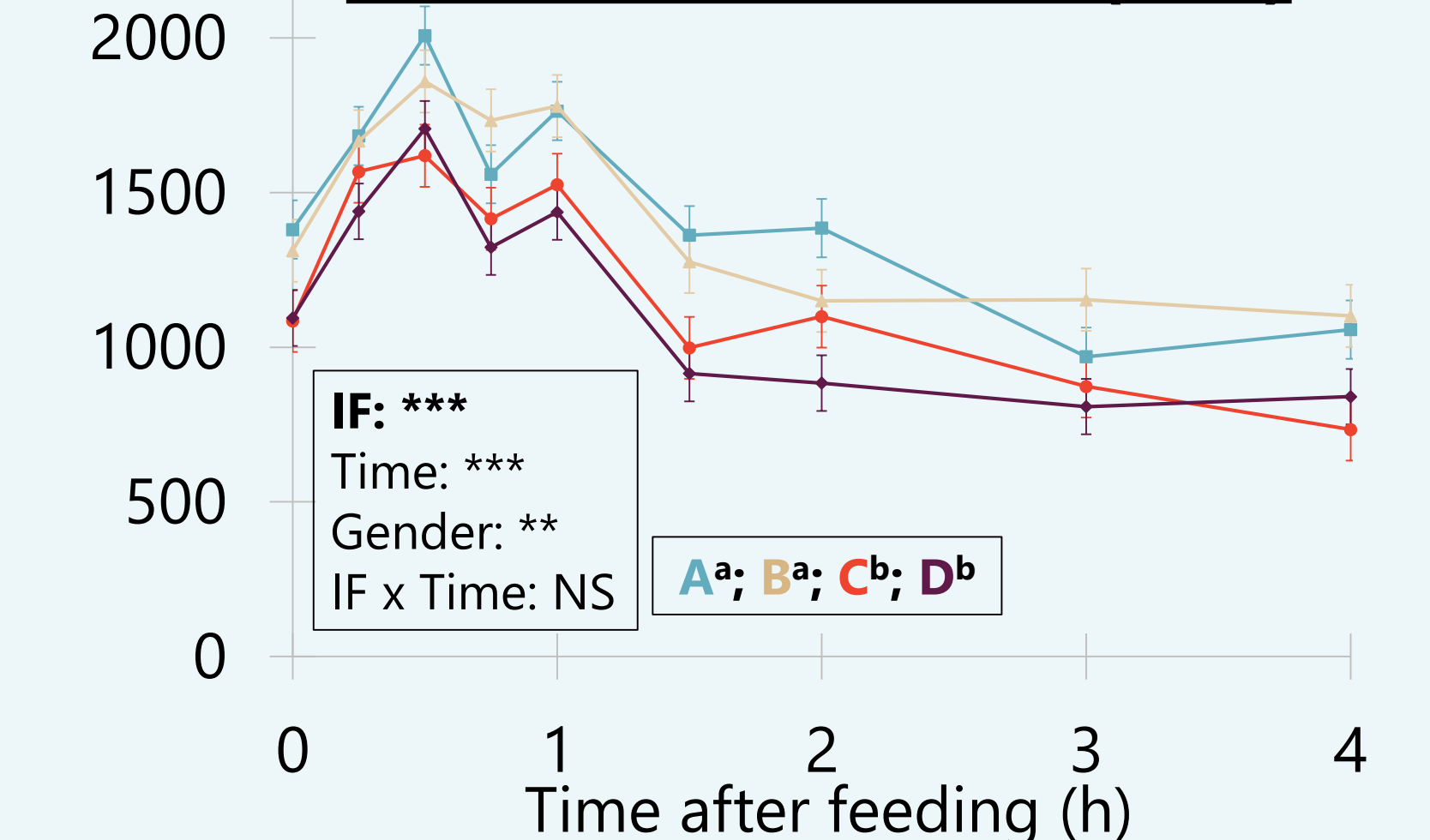
### IN VIVO DIGESTION AND ABSORPTION

#### Total amino acids (TAA)



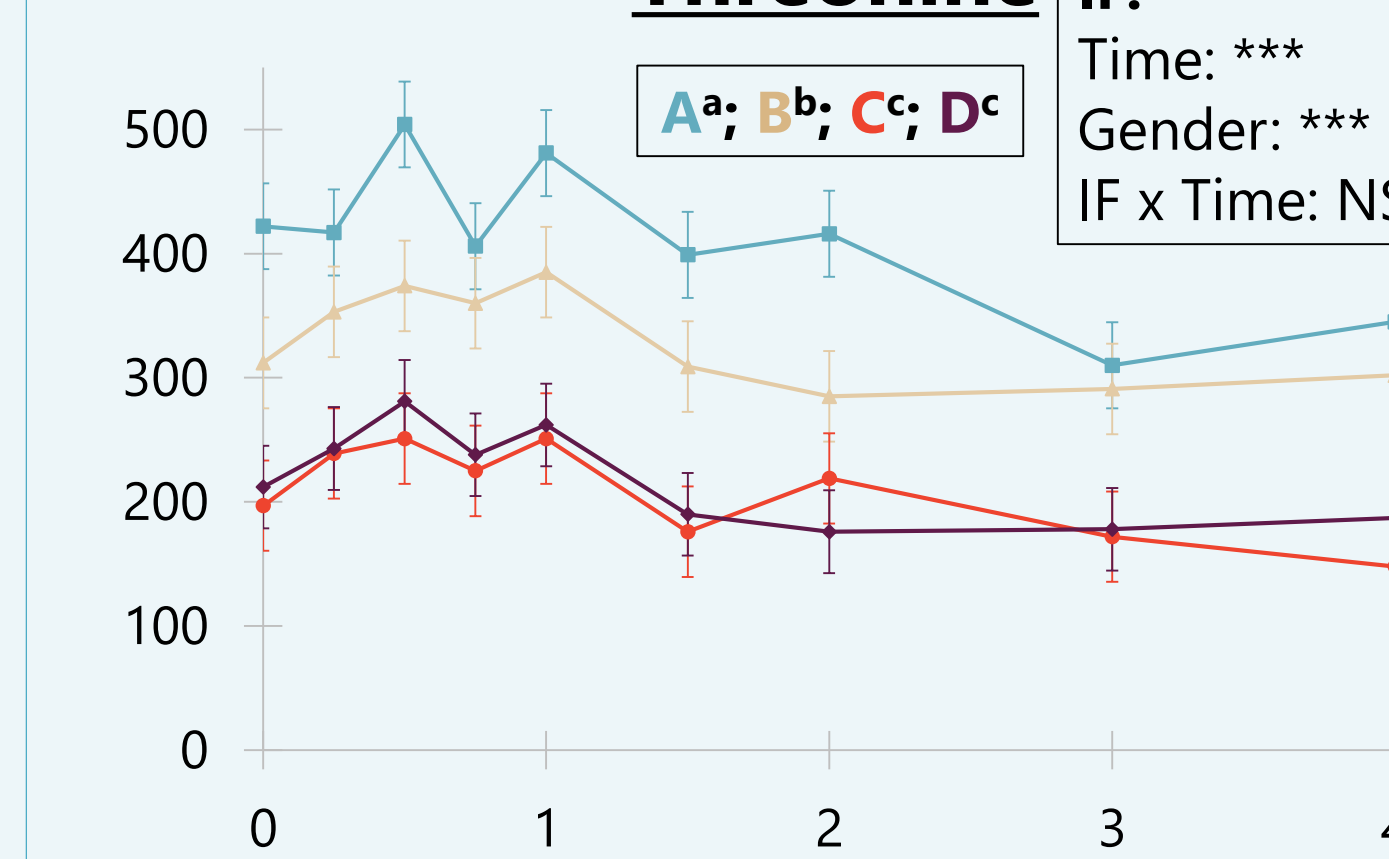
**Plasma TAA concentrations : IFs-A & -B > IFs-C (+17%) & -D (+12%) at both preprandial and postprandial times.**

#### Essential amino acids (EAA)



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

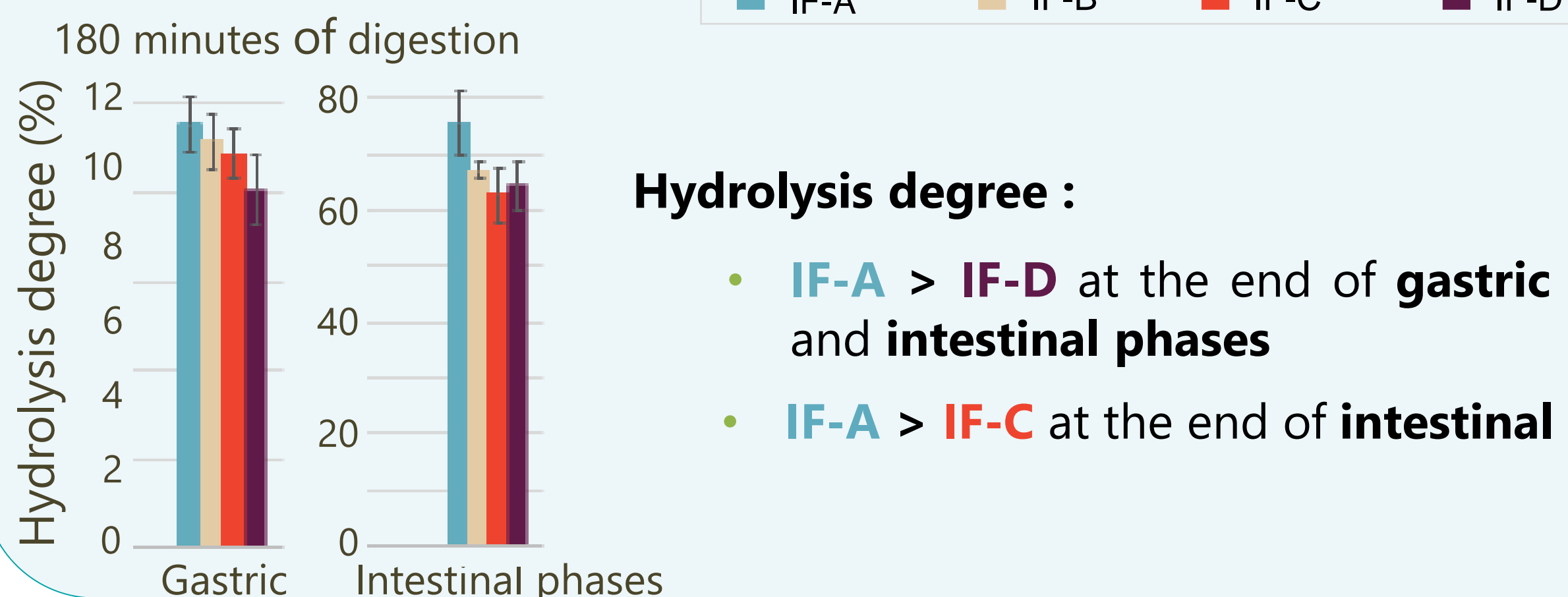
#### Threonine



↑ **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.

### PROTEOLYSIS



## 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**