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## **In vitro digestion of protein-rich dairy products in the ageing gastrointestinal tract**

Anaïs Lavoisier, Martine Morzel, Séverine Chevalier, Gwénaële Henry, Julien Jardin, Marielle Harel-Oger, Gilles Garric, Didier Dupont

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# ➤ *In vitro* digestion of protein-rich dairy products in the ageing gastrointestinal tract

Anaïs Lavoisier, Martine Morzel, Séverine Chevalier, Gwénaële Henry, Julien Jardin, Marielle Harel-Oger, Gilles Garric, Didier Dupont

November 7, 2023



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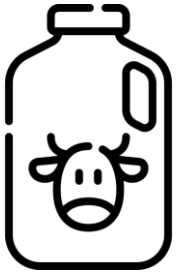
Insufficient protein intake may lead to sarcopenia, characterized by the loss of muscle mass, strength, and function.



Older adults > 65 years old need to increase the amount of high-quality proteins in their diet: at least 1 g protein /kg body weight /day.



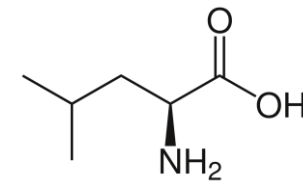
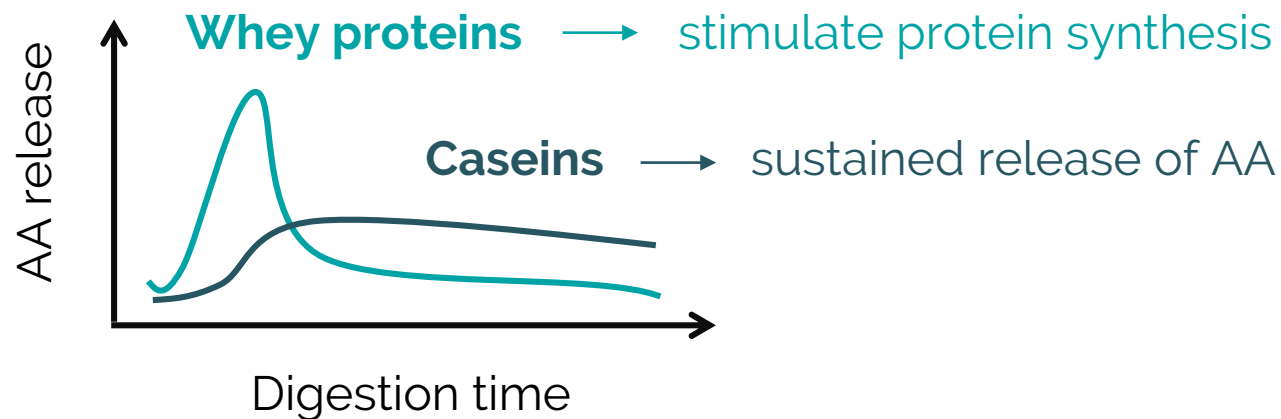
Ageing leads to changes in the functionality of the digestive tract but the impact of ageing on digestion, and absorption of nutrients is still unclear.



Milk proteins are interesting to promote muscle health: contain all the essential amino acids and have very high digestibility ratings.



Synergistic effect between caseins and whey proteins in milk to sustain the anabolic requirements during the whole postprandial period.



Leucine



Investigate *in vitro* the influence of age on the rate and extent of proteolysis of high-protein dairy products.



High-protein (10% w/w) dairy products considered suitable for older adults in terms of texture and oral comfort.

## Skyr

Commercial fermented dairy product containing mainly caseins

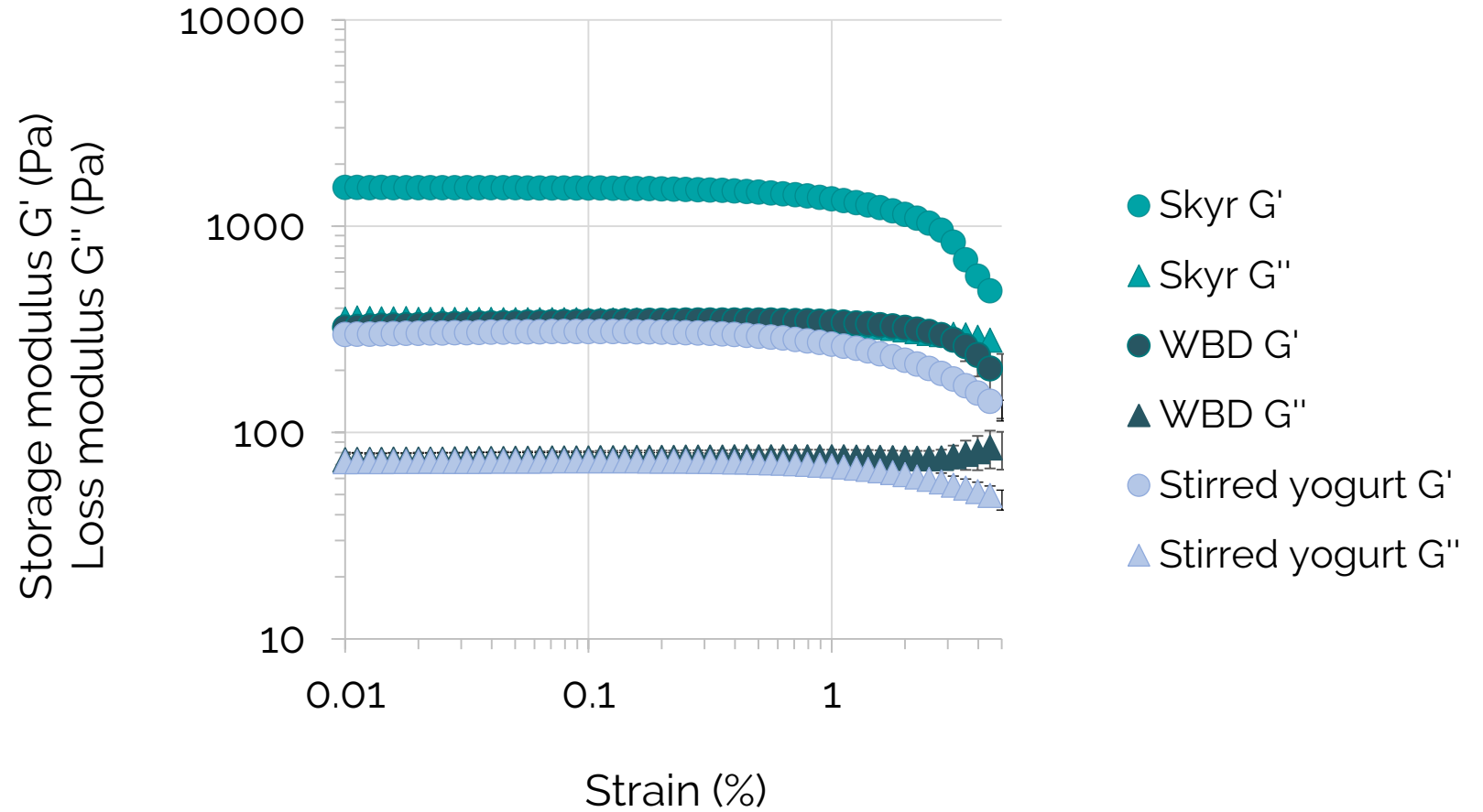
## Whey-based dairy (WBD)

Lab scale fermented dairy product, formulated with a ratio of whey proteins to caseins of 80 to 20 %, as opposed to milk

WBD had rheological properties comparable to a stirred yogurt.



Amplitude sweeps,  
1 Hz, 10°C.



WBD was acceptable to older adults, even with poor oral physiology (low number of posterior functional units, low salivary flow, and high saliva viscosity).



Panel of 80 subjects (49 women, 31 men), aged  $76 \pm 6$  y.



Ratings of food comfortability attributes for WBD:

**Oral comfort =  $83 \pm 20$  /100**

**Easy to eat =  $94 \pm 12$  /100**

## Static *in vitro* digestion

### Oral phase

1: 1 food: SSF dilution according to dry matter  
pH = 7.0, no chewing, no amylase

	Young adults	Older adults
<b>Gastric phase</b>		
pH:	3.0	↗ 3.7
Duration:	2 h	↗ 3 h
Pepsin:	2000 U ml <sup>-1</sup>	↘ 1200 U ml <sup>-1</sup>
Gastric lipase:	60 U ml <sup>-1</sup>	↘ 36 U ml <sup>-1</sup>
<b>Intestinal phase</b>		
[Ca <sup>2+</sup> ]:	0.6 mM	↗ 1 mM
pH:	7.0	7.0
Duration:	2 h	2 h
Pancreatin:	100 U ml <sup>-1</sup>	↘ 80 U ml <sup>-1</sup>
Bile salts:	10 mM	↘ 6.7 mM



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### Static *in vitro* digestion model adapted to the general older adult population: an INFOGEST international consensus

O. Menard,<sup>†a</sup> U. Lesmes,<sup>†b</sup> C. S. Shani-Levi,<sup>b</sup> A. Araiza Calahorra,<sup>c</sup> A. Lavoisier,<sup>a</sup> M. Morzel,<sup>a</sup> A. Rieder,<sup>†d</sup> G. Feron,<sup>e,f</sup> S. Nebbia,<sup>a</sup> L. Mashiah,<sup>b</sup> A. Andres,<sup>g</sup> G. Bornhorst,<sup>†h</sup> F. Carrière,<sup>†i</sup> L. Egger,<sup>†j</sup> S. Gwala,<sup>k</sup> A. Heredia,<sup>g</sup> B. Kirkhus,<sup>d</sup> A. Macierzanka,<sup>†l</sup> R. Portman,<sup>†l</sup> I. Recio,<sup>†m</sup> V. Santé-Lhoutellier,<sup>†n</sup> C. Tournier,<sup>e,f</sup> A. Sarkar,<sup>†c</sup> A. Brodkorb,<sup>k</sup> A. Mackie,<sup>†o</sup> and D. Dupont<sup>†\*a</sup>

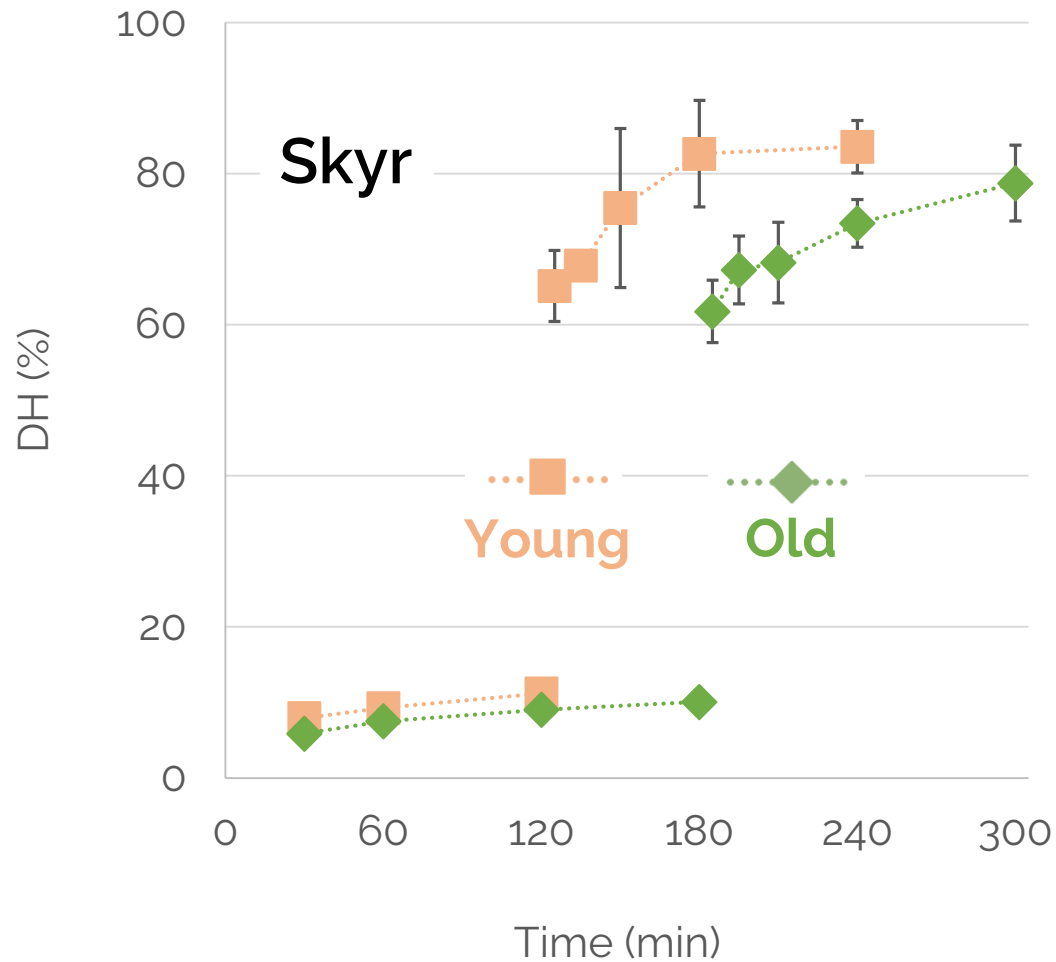


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*In vitro* digestion of protein-rich dairy products in the ageing gastrointestinal tract

Anais Lavoisier

## Degree of hydrolysis (DH), OPA method



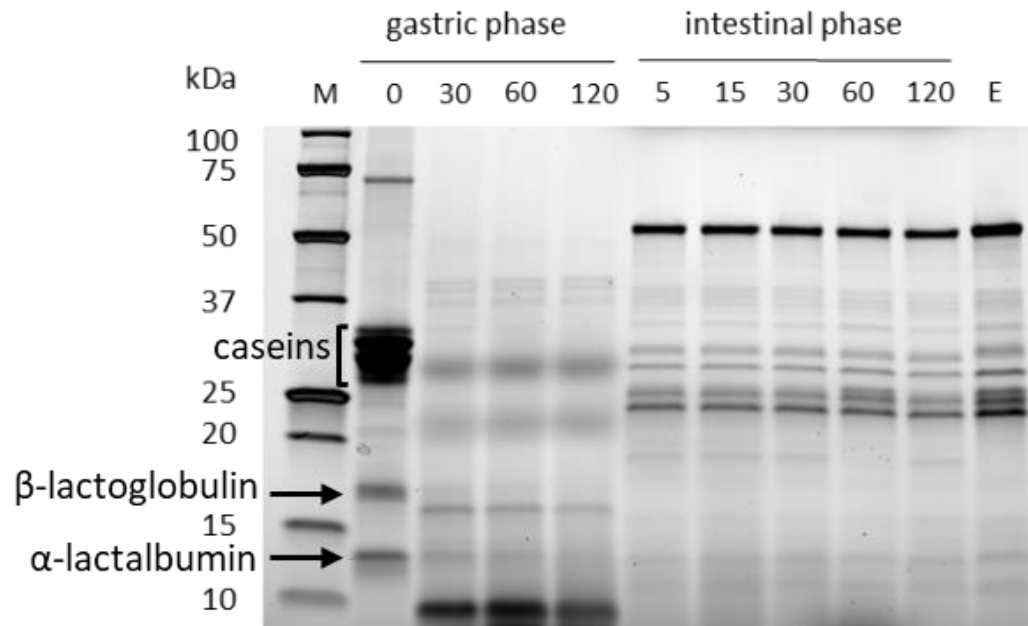
### Gastric phase

DH **old** < DH **young** during the whole gastric phase (**-20%**) due to the reduction in pepsin activity.

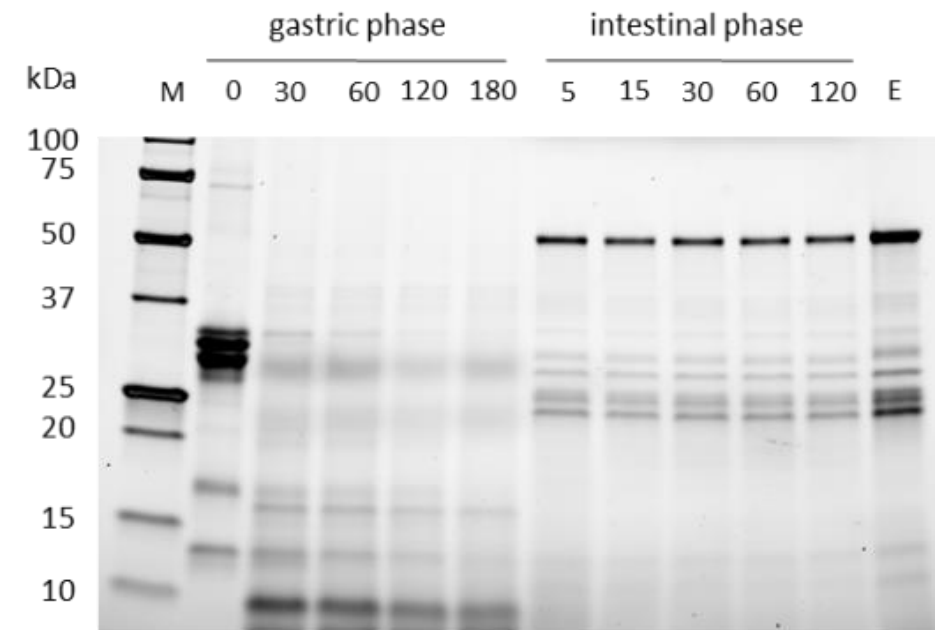
### Intestinal phase

High DH values reached at the end of the digestion: **75-85%** in both conditions.

# Protein hydrolysis, SDS-PAGE



**Skyr - Young**

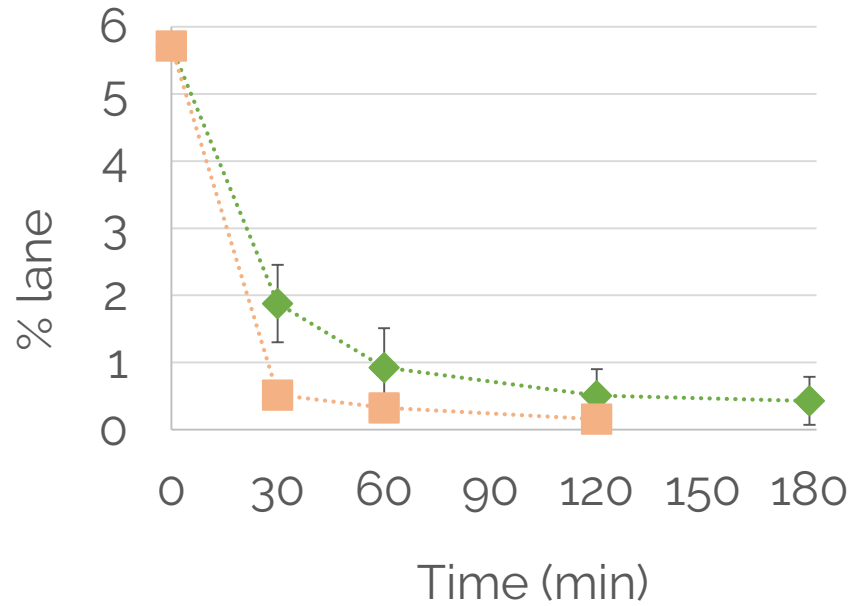


**Skyr - Old**

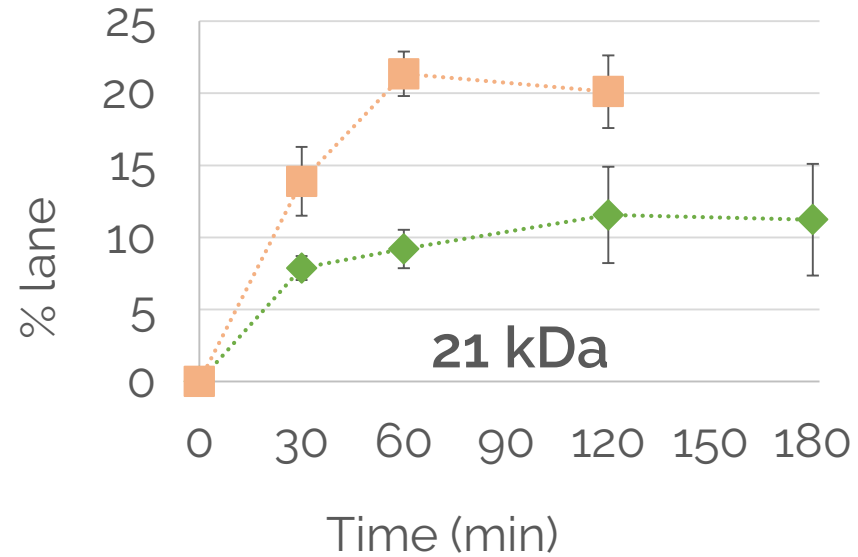
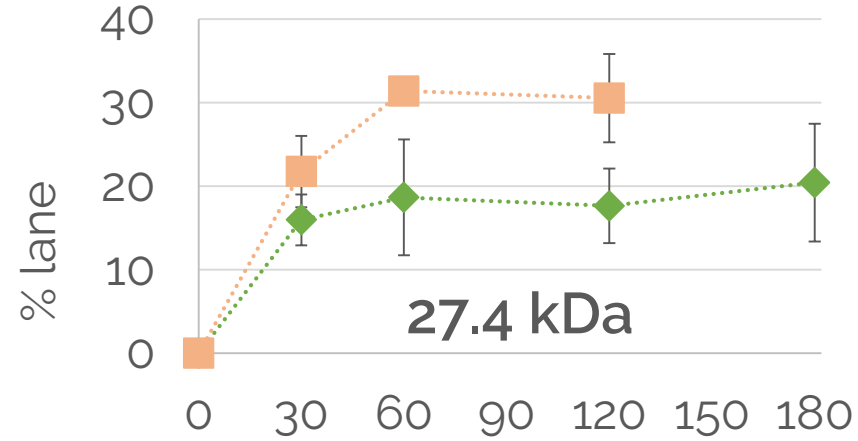
Caseins were rapidly digested by pepsin even at pH 3.7

# Protein hydrolysis, SDS-PAGE

## Decrease in $\alpha$ -s2-casein (32.6 kDa)



## Appearing protein fragments

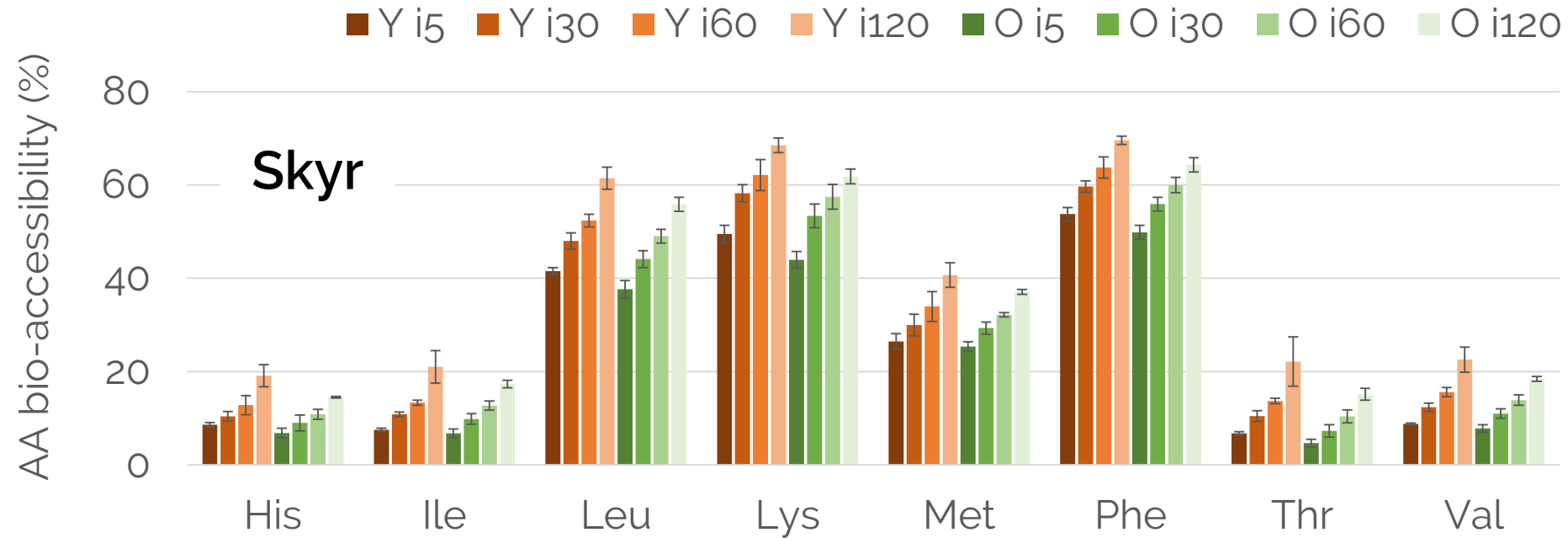


...■...  
Young

...◆...  
Old

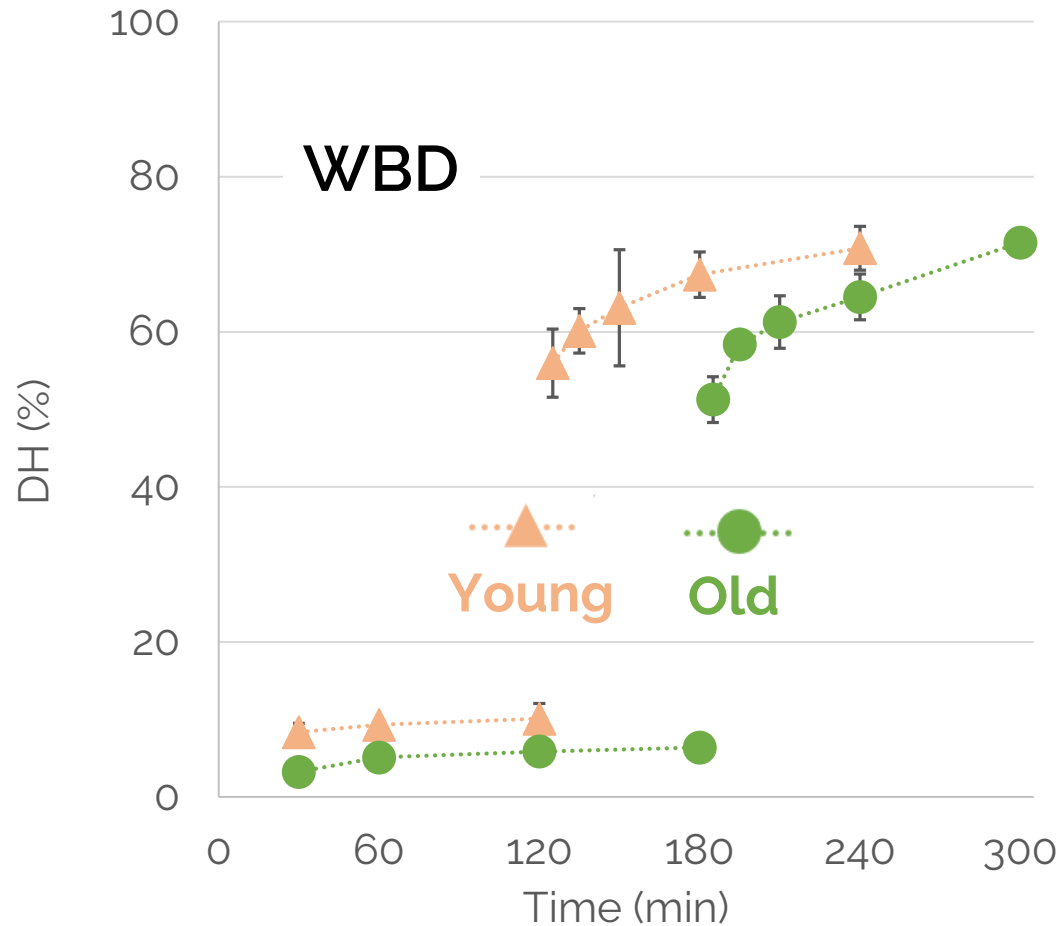


## Essential amino acids bio-accessibility, HPLC



Slightly less essential free AA with the older adult model: **-14%** overall, and **-10%** Leu at the end of the digestion (i120)

## Degree of hydrolysis (DH), OPA method



### Gastric phase

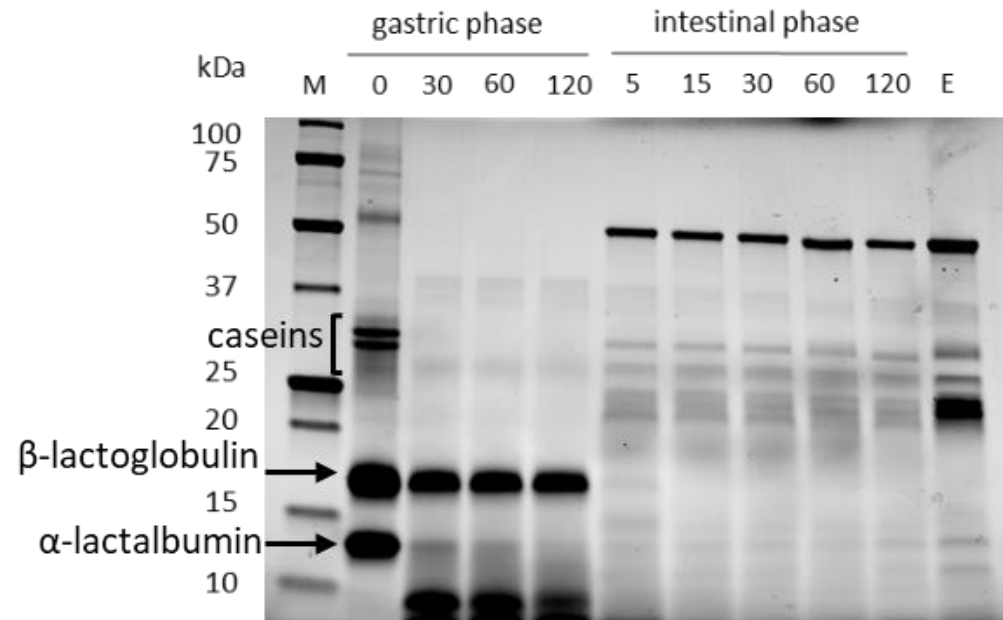
No changes in DH **after 30 min (young)** or **60 min (old)** in the gastric phase.

DH **old** < DH **young** at the end of the gastric phase (**-37%**) due to the reduction in pepsin activity.

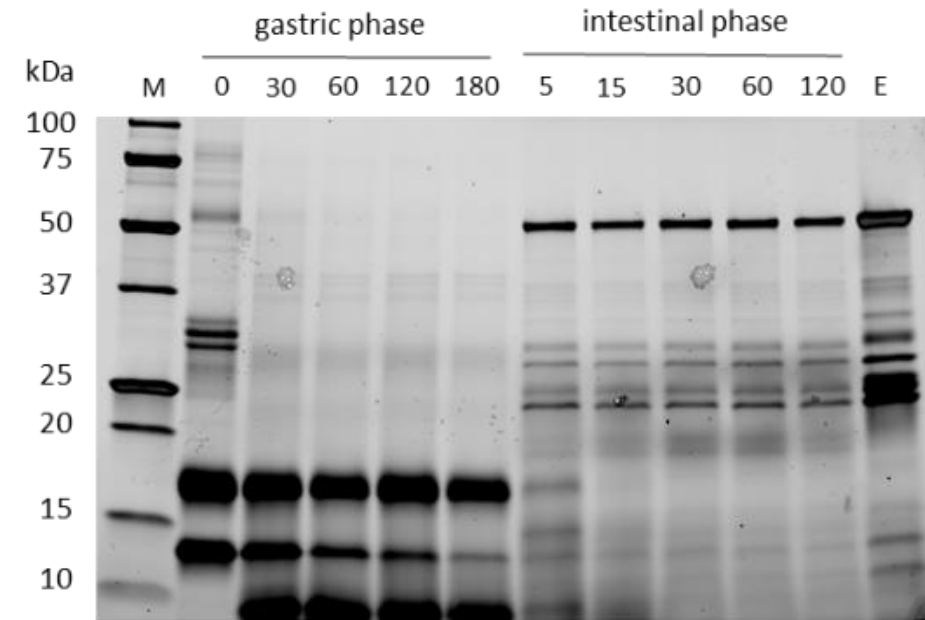
### Intestinal phase

High DH values reached at the end of the digestion: approx. 70% in both conditions.

# Protein hydrolysis, SDS-PAGE



WBD - Young

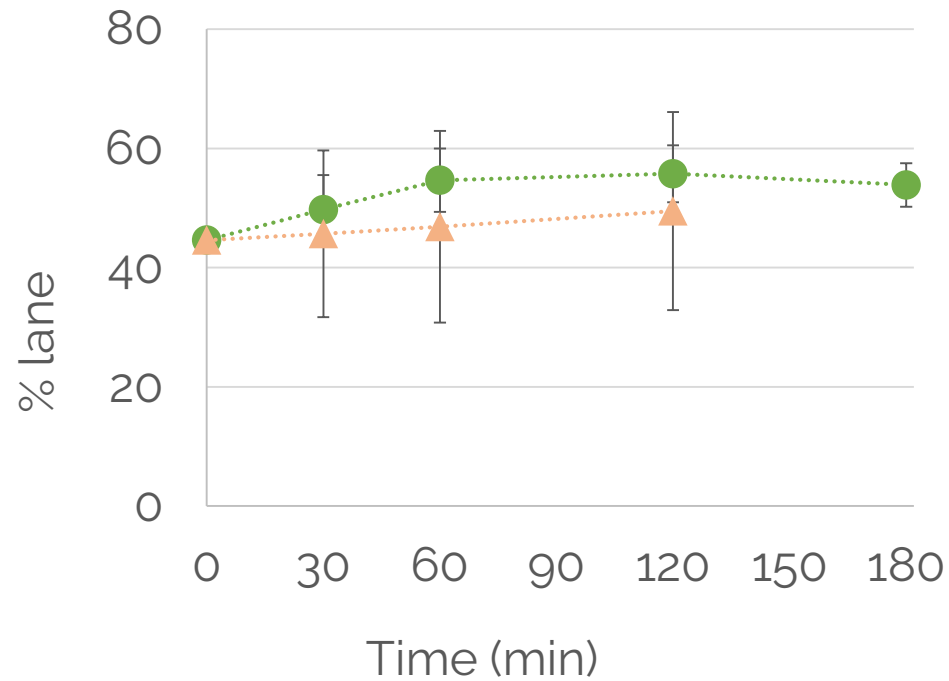


WBD - Old

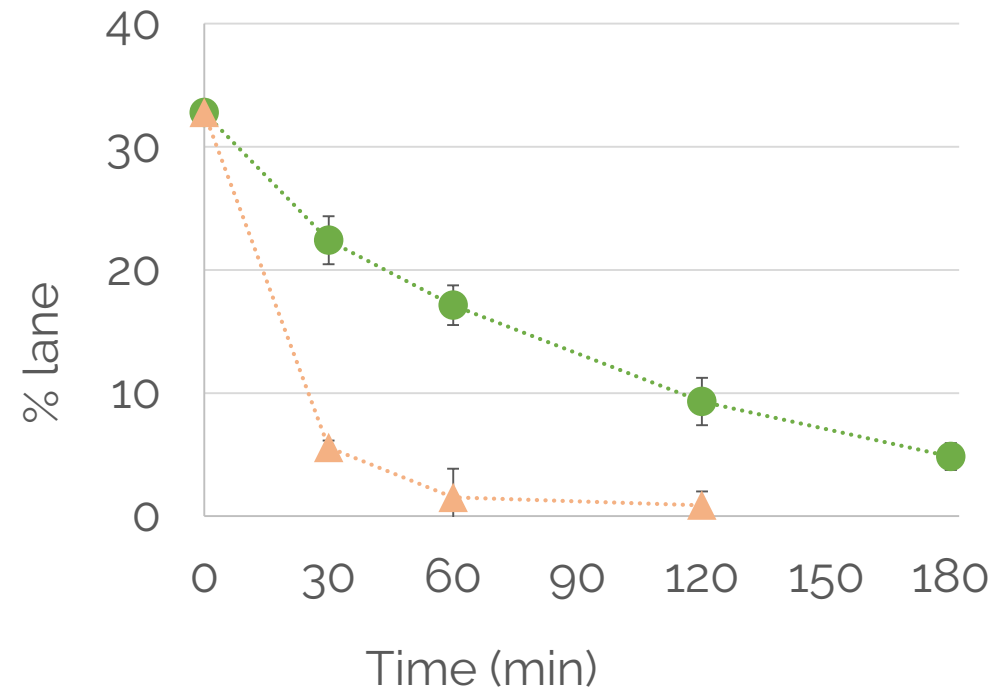
$\beta$ -lactoglobulin was resistant to pepsin

# Protein hydrolysis, SDS-PAGE

## Resistant $\beta$ -lactoglobulin (16.6 kDa)

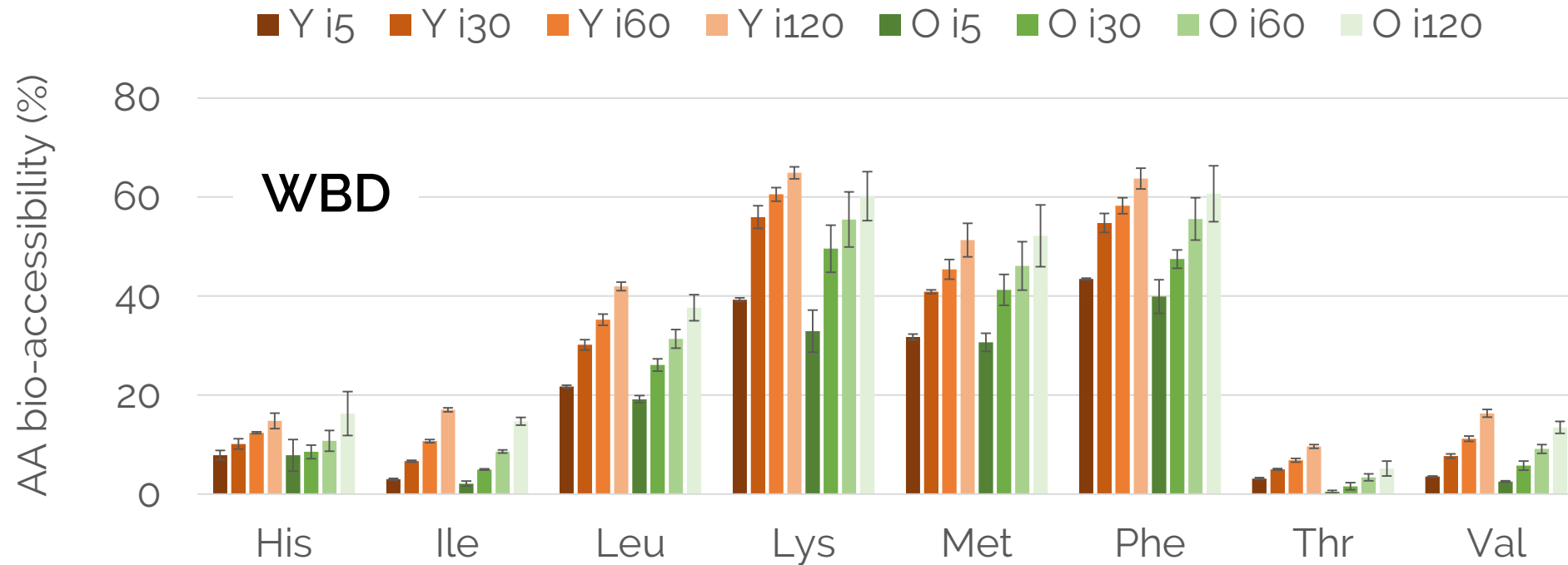


## Decrease in $\alpha$ -lactalbumin (12.6 kDa)



▲ Young  
● Old

# Essential amino acids bio-accessibility, HPLC



No significant differences between young and older adults during the whole intestinal phase.



*In vitro* digestion conditions influenced the kinetics and extent of proteolysis, but differences were mainly observed in the gastric phase.



Different scenarios were observed depending on the composition of the dairy product studied.

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## ***In vitro* digestion of two protein-rich dairy products in the ageing gastrointestinal tract†**

Anaïs Lavoisier, \* Martine Morzel, Séverine Chevalier, Gwénaële Henry, Julien Jardin, Marielle Harel-Oger, Gilles Garric and Didier Dupont



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*In vitro* digestion of protein-rich dairy products in the ageing gastrointestinal tract

Anaïs Lavoisier



Cream cheeses with 24% lipids and different WP:CAS ratios have been formulated and digested *in vitro*.



A clinical study comparing the effect of WBD, Skyr, and cream cheese on young and older adults' postprandial muscle synthesis is underway.

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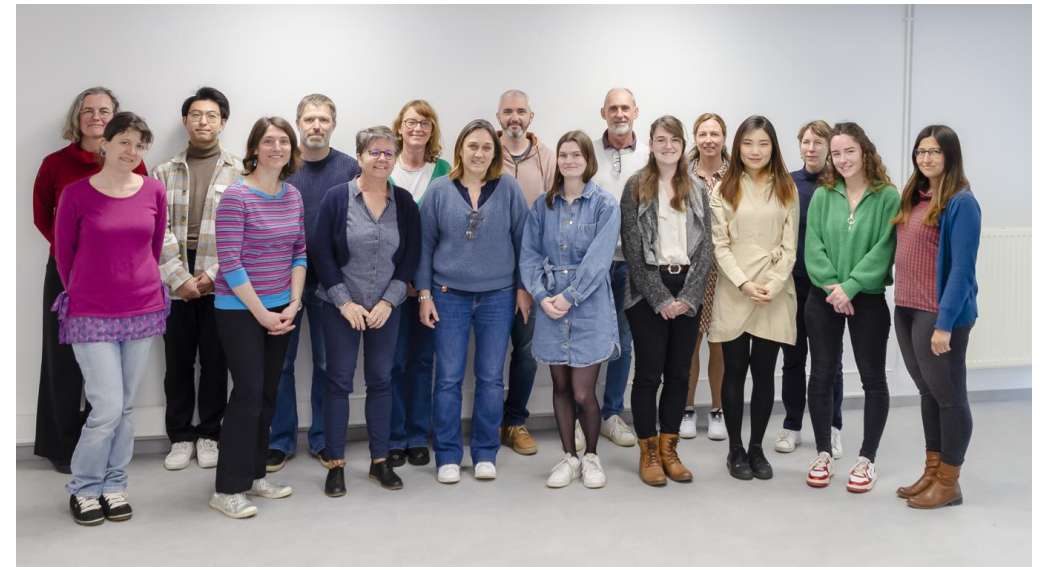
# Thank you



EAT4age  
Palatable, nutritious and digestible foods for prevention  
of undernutrition in active aging



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Bioactivity and Nutrition (BN) team



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*In vitro* digestion of protein-rich dairy products in the ageing gastrointestinal tract  
Anais Lavoisier