



NUTRITION 2022

Growth retardation induced by protein and indispensable amino acid deficiencies can not be catch up by a supplementation in growing rats



Gaëtan Roisné-Hamelin¹, Catherine Chaumontet¹, Juliane Calvez¹, Claire Gaudichon¹, Dalila Azzout-Marniche¹

¹Université Paris-Saclay, AgroParisTech, INRAE, UMR PNCA, 75005, Paris, France



American Society for Nutrition
Excellence in Nutrition Research and Practice
www.nutrition.org

Where the Best in Science & Health Meet
June 14-16, 2022 | #NutritionLiveOnline

Disclosures

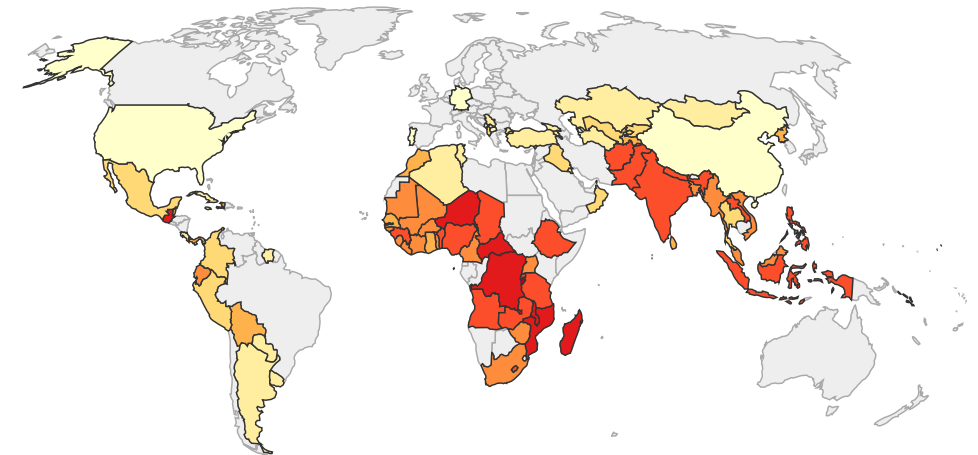
No conflict to disclose

Introduction

- In developing countries, children are exposed to a risk of growth retardation.
- Among the causes :
 - Lack of diversity in the diet^{1,2}
 - Low protein intake³
 - Poor quality of protein sources²

Share of children that are stunted, 2020

The share of children younger than five years old that are defined as stunted. Stunting is when a child is significantly shorter than the average for their age, as a consequence of poor nutrition and/or repeated infection.



Source: UNICEF, World Health Organization and World Bank

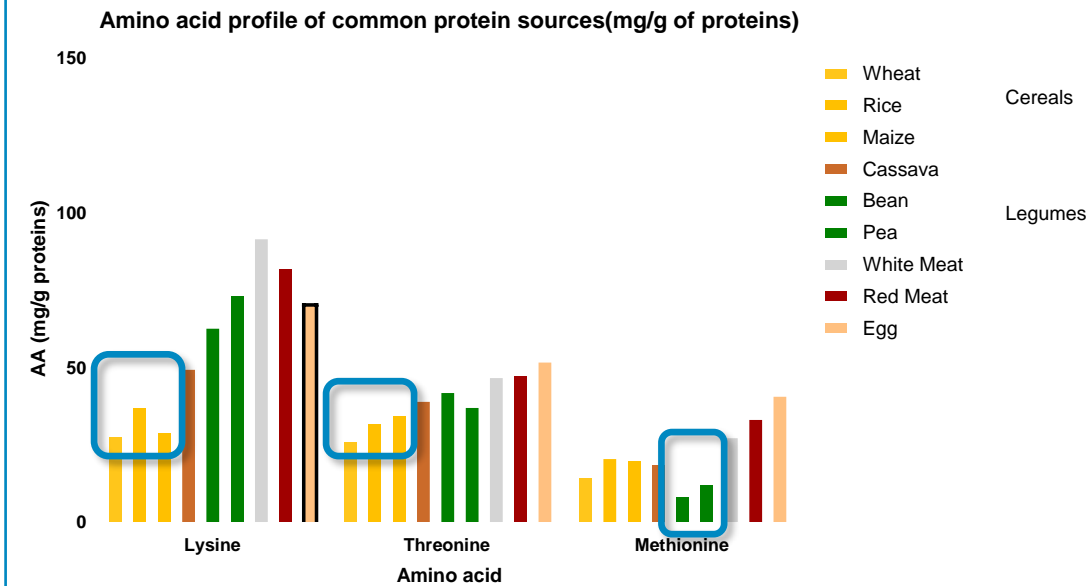
OurWorldInData.org/hunger-and-undernourishment • CC BY

Stunting = Low height for age



Introduction

- Quality of protein sources:
 - $$\text{DIAAS} = \frac{\text{mg limiting AA in the source}}{\text{mg same AA in reference protein}} \times \text{Ileal Digestible AA}$$
- Effect of a supplementation:
 - ↗Linear growth ¹ (milk based protein and MMN)
 - ↗Length gain, ↘Stunting and underweight ² (egg)
 - ↘Diarrheal episode, ↗Weight gain ³ (lysine)
 - ↗Overall growth outcomes, but not systematic ⁴
- Lack of knowledge:
 - Can we catch-up a growth retardation ?
 - Is there a specificity between protein and a single IAA deficiency ?
- Aim of the study:
 - Assess the supplementation efficiency following a protein or IAA (lysine, threonine or methionine) deficiencies in growing rats
 - Identify the specific IAA deficiency effect



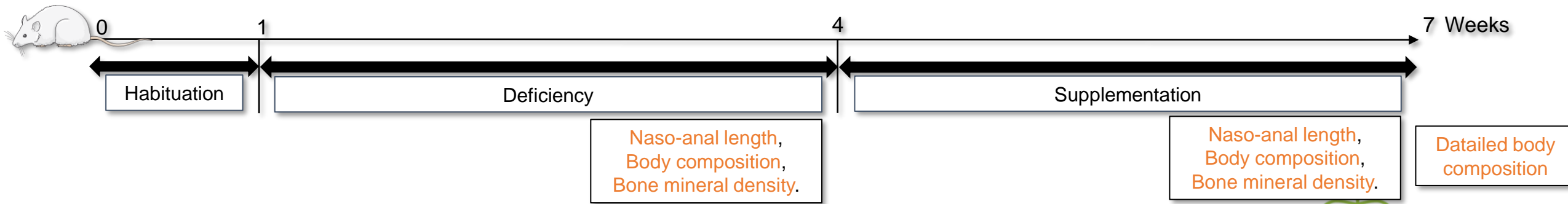
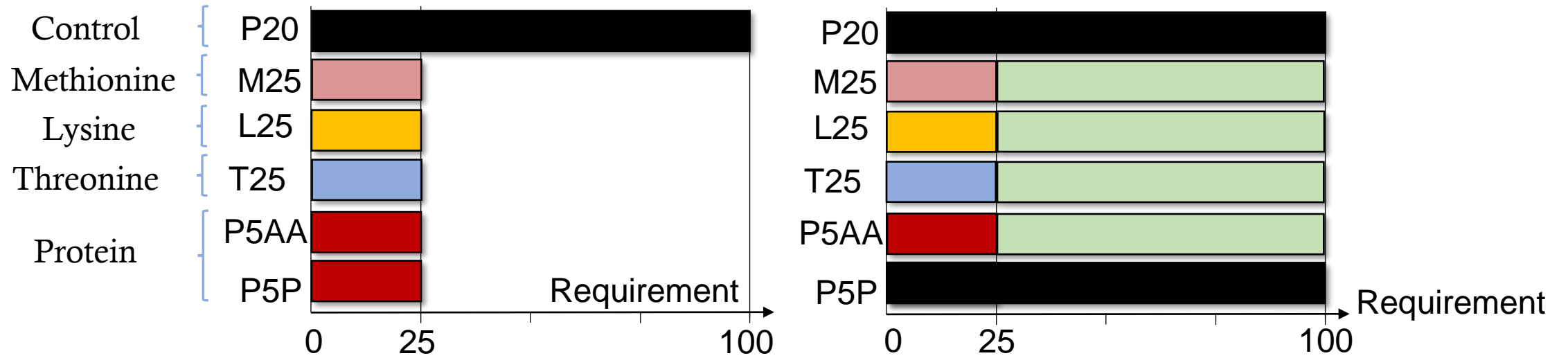
*DIAAS = Digestible indispensable amino acid score

June 14-16, 2022 | #NutritionLiveOnline

NUTRITION **LIVE ONLINE** 2022

¹Sunita Taneja 2021b; ²Lora L. Lannotti 2019; ³Shibani Gosh 2019; ⁴Joanne E. Arsenault 2017;

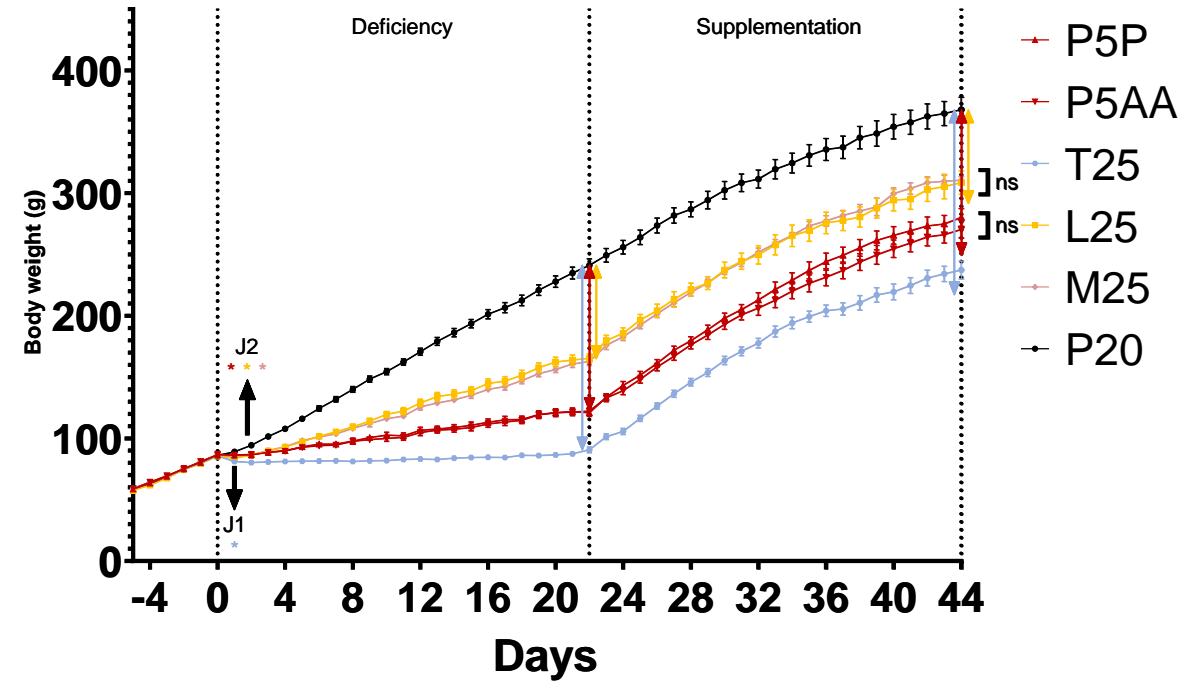
Material and methods



Results

- BW gain is reduced by a protein and a single IAA deficiency.
- BW gain was the lowest for a threonine deficiency, and lower for a protein deficiency vs lysine/methionine deficiencies.
- When rats were fed by their supplementation diet, all groups saw their growth resumes.
- We only observed a slightly catch-up on d1, which do not permit to catch-up the growth retardation.
- No catch-up growth was observed from d2 until the end of the supplementation.

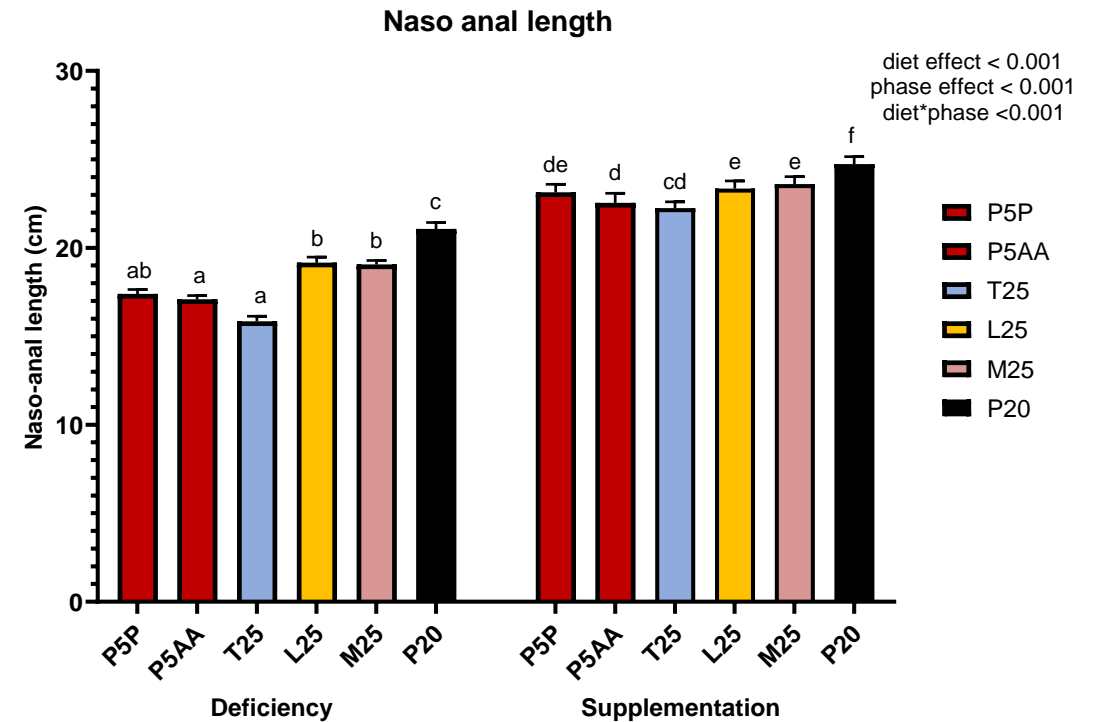
Body weight



Diet	hab	def	1d sup.	Rest of sup.
P20	5,41±0,60	7,05±0,67	8,20±0,33	5,68±1,06
M25	5,74±0,46	3,45±0,79	13,19±0,82	6,48±1,26
L25	5,55±0,59	3,63±0,71	14,42±1,42	6,02±1,38
P5P	5,67±0,59	1,54±0,65	12,69±0,85	6,89±1,01
P5AA	5,55±0,67	1,62±0,53	10,69±0,77	6,39±0,89
T25	5,26±0,58	0,22±0,48	10,75±1,25	6,53±0,90

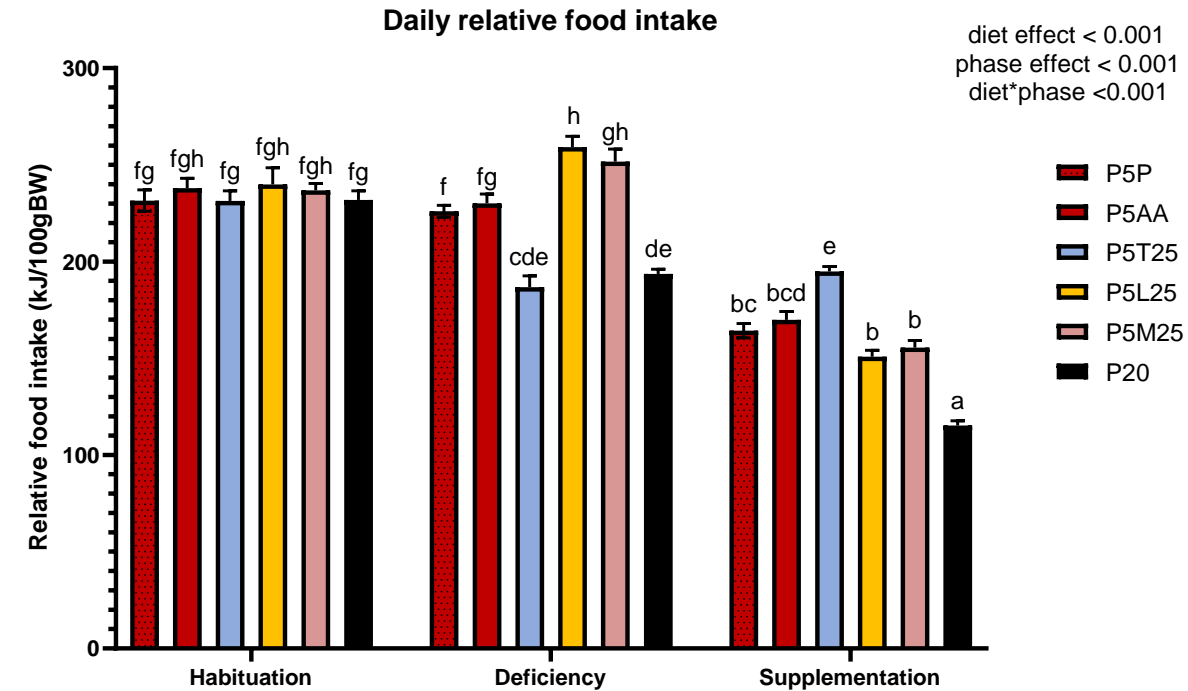
Results

- The NAL is decreased by protein as IAA deficiencies.
- A lower NAL is still observed after the supplementation.



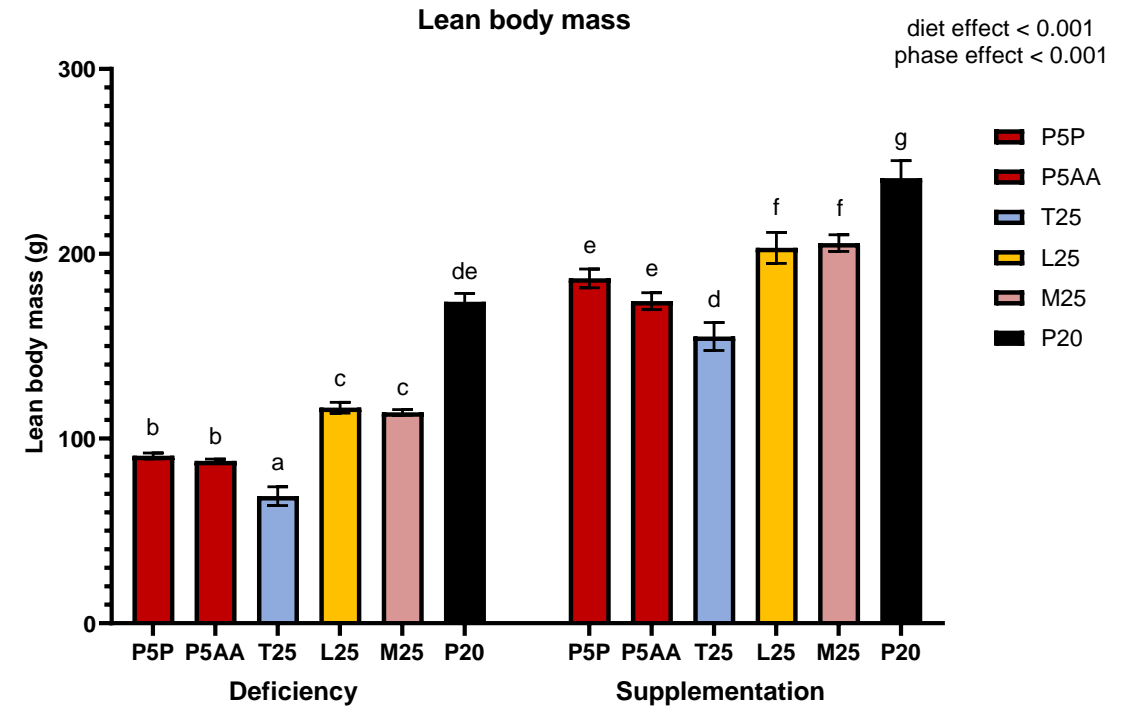
Results

- Rats increased their relative food intake during protein or IAA deficiencies (except for threonine).
- During supplementation, the protein- and IAA-deficient groups preserved a higher food intake.



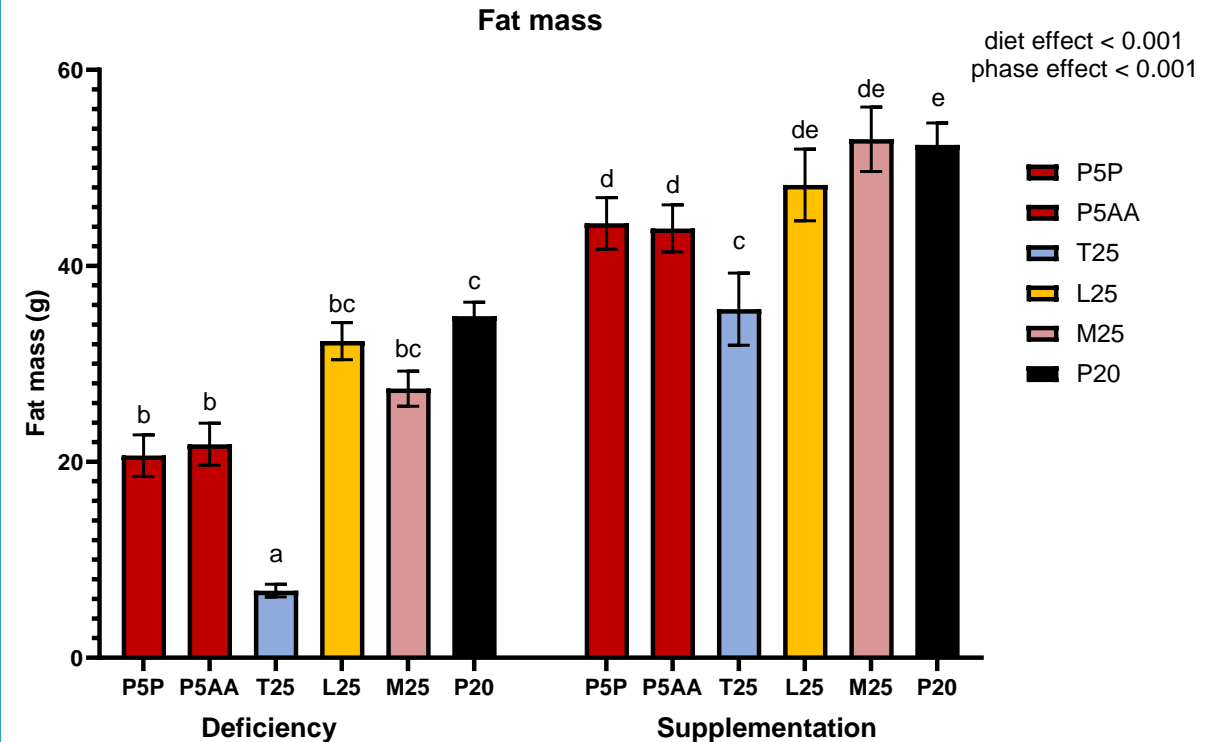
Results

- LBM is highly affected by the deficiencies.
- LBM is decreased by protein deficiency as well as IAA.
- LBM remains decreased after supplementation.



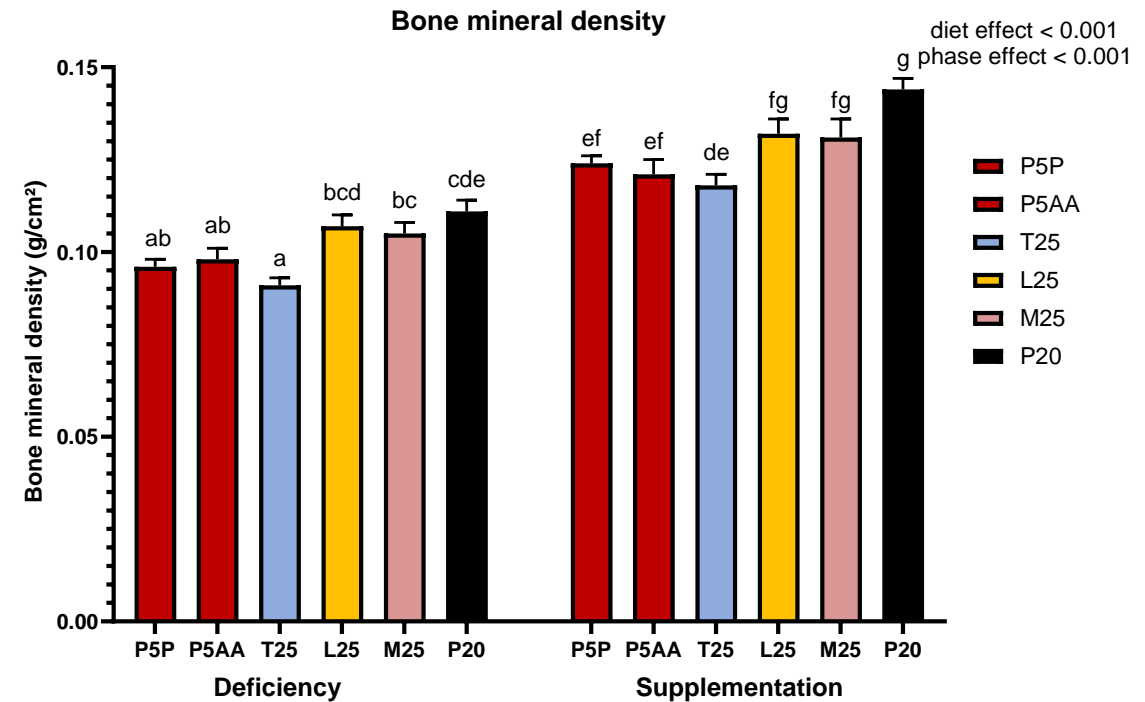
Results

- Fat mass is decreased by a protein deficiency such as threonine deficiency.
- Fat mass is not decreased by lysine or methionine deficiencies.
- Fat mass remains reduced after supplementation (P5-T25).



Results

- Bone mineral density is reduced by a protein as IAA deficiencies.
- The gap remains after supplementation.



Results

Diet	P5P	P5AA	P5T25	P5L25	P5M25	P20	Diet effect
Lean body mass (g)	216.76±5.72 ^{bc}	206.40±4.57 ^{ab}	187.47±4.93 ^a	240.36±8.46 ^c	241.63±5.27 ^c	290.03±8.56 ^d	p < 0.001
Liver (g)	9.76±0.40 ^{ac}	9.07±0.31 ^{ab}	8.48±0.43 ^a	10.63±0.51 ^{bc}	11.02±0.51 ^c	10.98±0.42 ^c	p < 0.001
Kidney (g)	1.95±0.06 ^{bc}	1.72±0.05 ^{ab}	1.64±0.03 ^a	2.01±0.06 ^c	1.95±0.05 ^{bc}	2.36±0.09 ^d	p < 0.001
Gastrocnemius muscle (g)	2.49±0.15 ^{ab}	2.47±0.07 ^{ab}	2.28±0.06 ^a	2.83±0.10 ^b	2.74±0.07 ^b	3.27±0.06 ^c	p < 0.001
Carcass (g)	110.79±3.03 ^{ab}	105.93±2.64 ^a	96.15±2.25 ^a	126.19±4.91 ^c	123.70±3.09 ^{bc}	152.30±4.95 ^d	p < 0.001

- The decrease in LBM is reflected in the weight of the kidneys, gastrocnemius muscle and carcass.
- However, the liver has a different behavior.
 → Liver = Organ that can make up for stunted growth?

Results

Diet	P5P	P5AA	P5T25	P5L25	P5M25	P20	Diet effect
Fat mass (g)	33.83±2.36 ^{ab}	34.66±1.56 ^{ab}	25.70±2.10 ^a	36.85±2.88 ^{bc}	40.61±2.33 ^{bc}	44.70±2.38 ^c	p < 0.001
Adiposity (%)	13.42±0.70	14.38±0.57	11.98±0.80	13.26±0.81	14.42±0.86	13.37±0.65	NS
Epididymal fat (g)	5.36±0.45 ^b	4.98±0.27 ^b	3.33±0.24 ^a	5.41±0.32 ^{bc}	6.18±1.33 ^{bc}	6.97±0.56 ^c	p < 0.001
Mesenteric fat (g)	4.74±0.31 ^{ab}	4.55±0.20 ^{ab}	3.87±0.27 ^a	5.80±0.49 ^{bc}	5.85±0.22 ^{bc}	6.59±0.50 ^c	p < 0.001
Retroperitoneal fat (g)	5.69±0.42 ^b	5.70±0.40 ^b	3.42±0.32 ^a	6.28±0.50 ^b	7.15±0.40 ^{bc}	8.20±0.43 ^c	p < 0.001
Subcutaneous fat (g)	17.59±1.36 ^{ab}	18.94±0.98 ^{ab}	14.65±1.44 ^a	18.77±1.73 ^{ab}	20.87±1.58 ^b	22.43±1.29 ^b	p < 0.05
Brown adipose tissue (g)	0.45±0.05	0.50±0.05	0.43±0.03	0.58±0.06	0.57±0.04	0.51±0.02	NS

- The decrease in fat mass was found on the EAT, MAT, RAT.
- Only threonine impacted the SCAT.
- In addition, the adiposity and BAT were not impacted by any diet.
→ Maintenance of adiposity and TAB?

Conclusion

- Aim of the study:
 - To evaluate the efficiency of supplementation following protein or IAA (lysine, threonine or methionine) deficiency in growing rats.
- A specific deficiency in an IAA such as protein induces growth retardation, and the LBM is particularly affected.
- Supplementation allows growth resumes, but the growth retardation cannot be recovered.
- Body weight, NAL, BMD remain decreased after protein deficiency or IAA.
- Body fat and BMD remain decreased after protein or threonine deficiency.
- Identify the specific effects of each IAA.
 - We did not observed a specific effect between lysine and methionine.
 - The protein diet supplementation was as efficient as the semicrystalline diet.
 - The more pronounced effect of threonine deficiency could be due to a poor estimation of threonine requirement.
 - We observed no beneficial effect of methionine restriction.