14TH EUROPEAN NUTRITION CONFERENCE
FENS 2023, Belgrade, Serbia
Sava Center
14-17th November 2023

Organised by the European Milk Forum

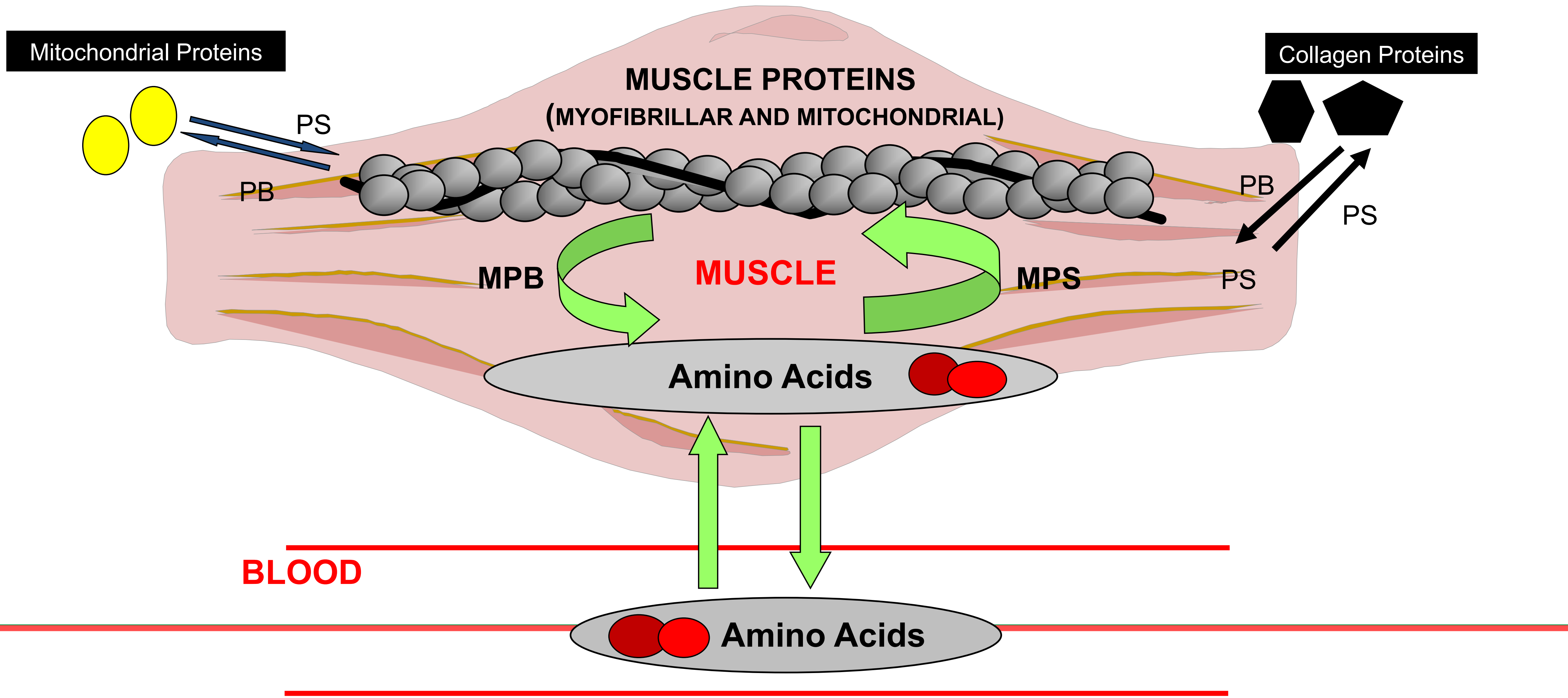
KING'S College LONDON

A food-first approach to protein recommendations: THE MATRIX effect

Dr Oliver C. Witard
Senior Lecturer in Exercise Metabolism and Nutrition

oliver.witard@kcl.ac.uk
@OllyWitard

The muscle anabolic response is primarily mediated by changes in rates of muscle protein synthesis in response to exercise and protein feeding



Conflict of Interest Disclosure

I have no conflict of interest to report in relation to this presentation.

This  presentation aims to ...

KING'S College LONDON

1. Define food matrix in the context of protein recommendations

2. Highlight the efficacy of animal, plant and alternative protein-rich foods to stimulate muscle protein synthesis

   a. Examine the influence of nutrient-nutrient interactions in modulating the MPS response to ingested protein-rich foods

   b. Examine the influence of non-nutrient components (physical structure and processing) in modulating the MPS response to ingested protein-rich foods

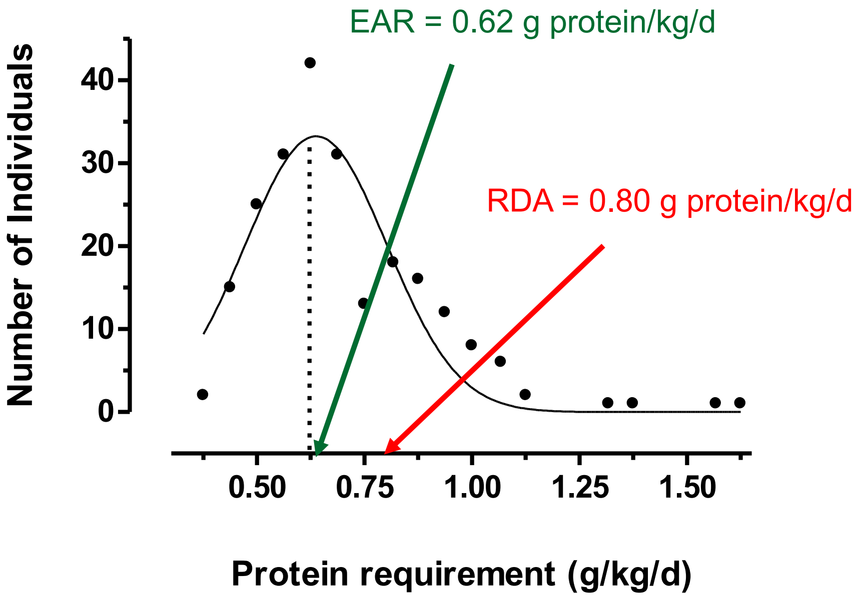
3. Should we, as nutrition professionals, redefine protein recommendations to account for the food matrix effect?

Distinguishing between the term's protein requirement and protein recommendations

KING'S College LONDON

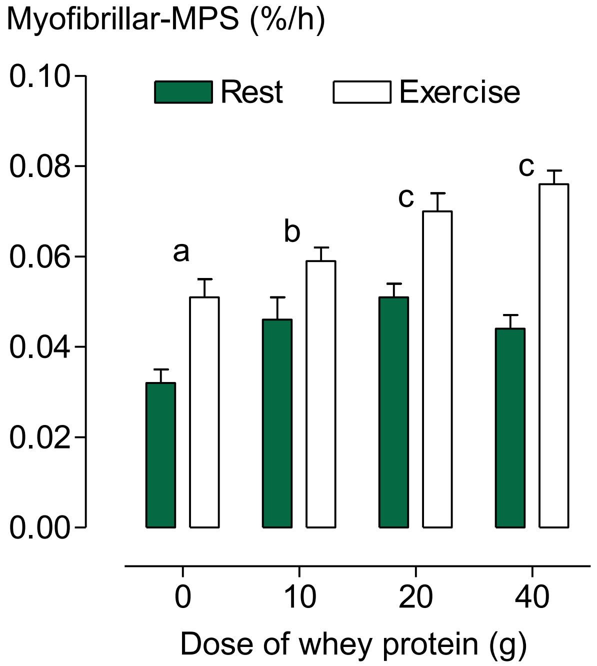
Protein requirement

"The minimum daily protein intake necessary to satisfy the metabolic demands of the body which includes the maintenance of body composition"



Protein recommendation

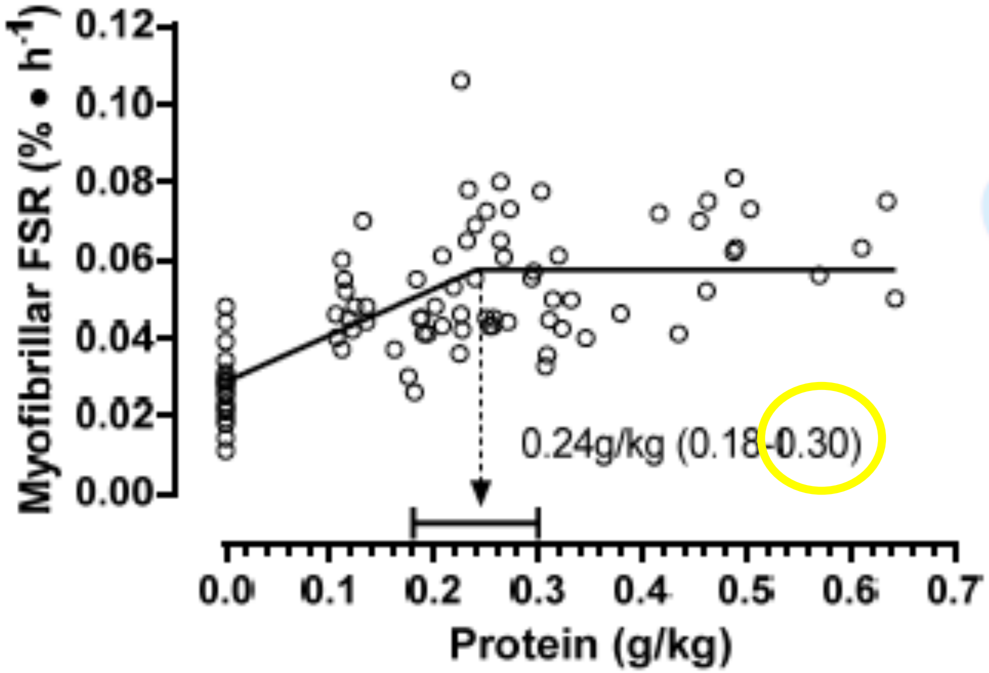
"The protein intake that may facilitate an adaptive advantage and/or optimise performance"



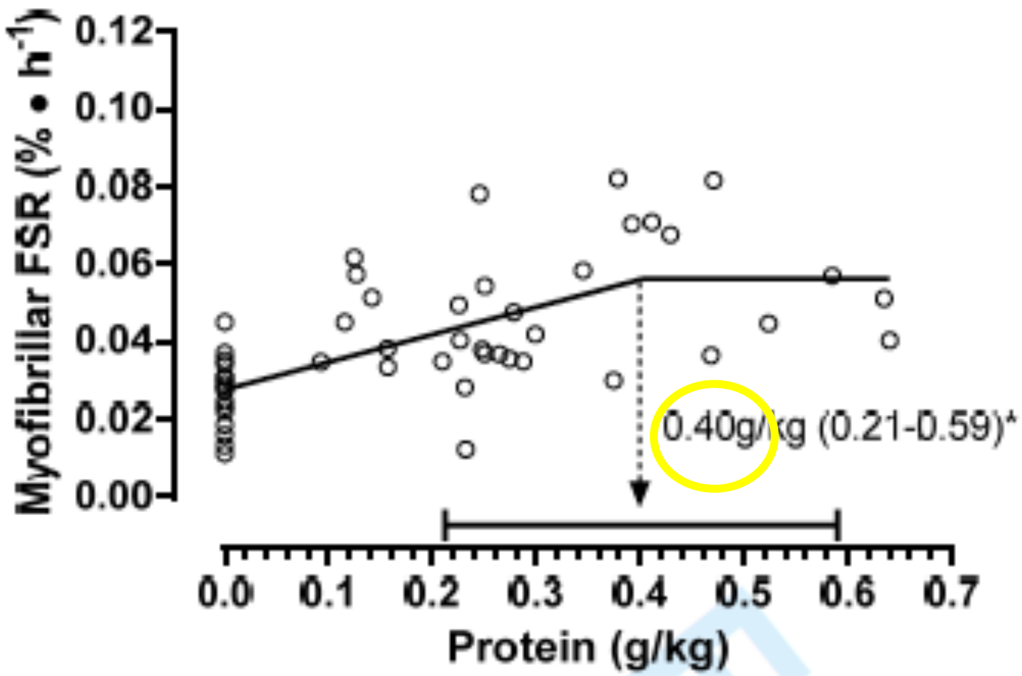
Millward. 2001 Can J Appl Physiol, 26: S130-140
Rand et al. 2003 Am J Clin Nutr, 77(1): 109-127
Tipton & Wolfe. 2004 Journal of Sport Sciences, 22(1): 65-79
Witard et al. 2014 Am J Clin Nutr, 99(1): 86-95

The optimal protein dose for maximal stimulation of MPS is ~0.24 g/kg BM per meal in young adults and ~0.40 g/kg BM per meal in older adults

Young (18-35 years) men

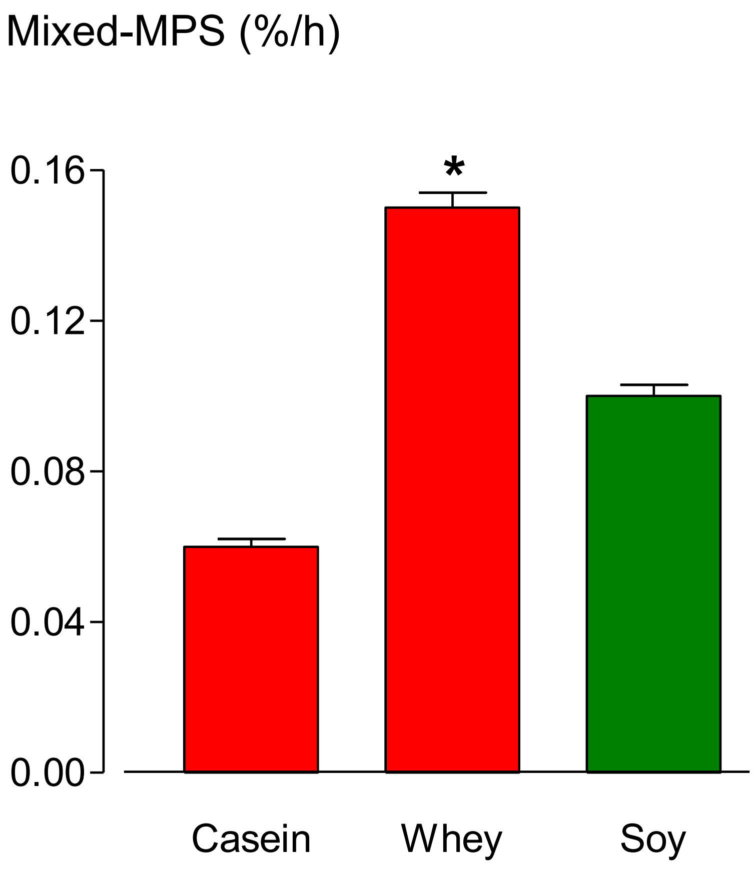


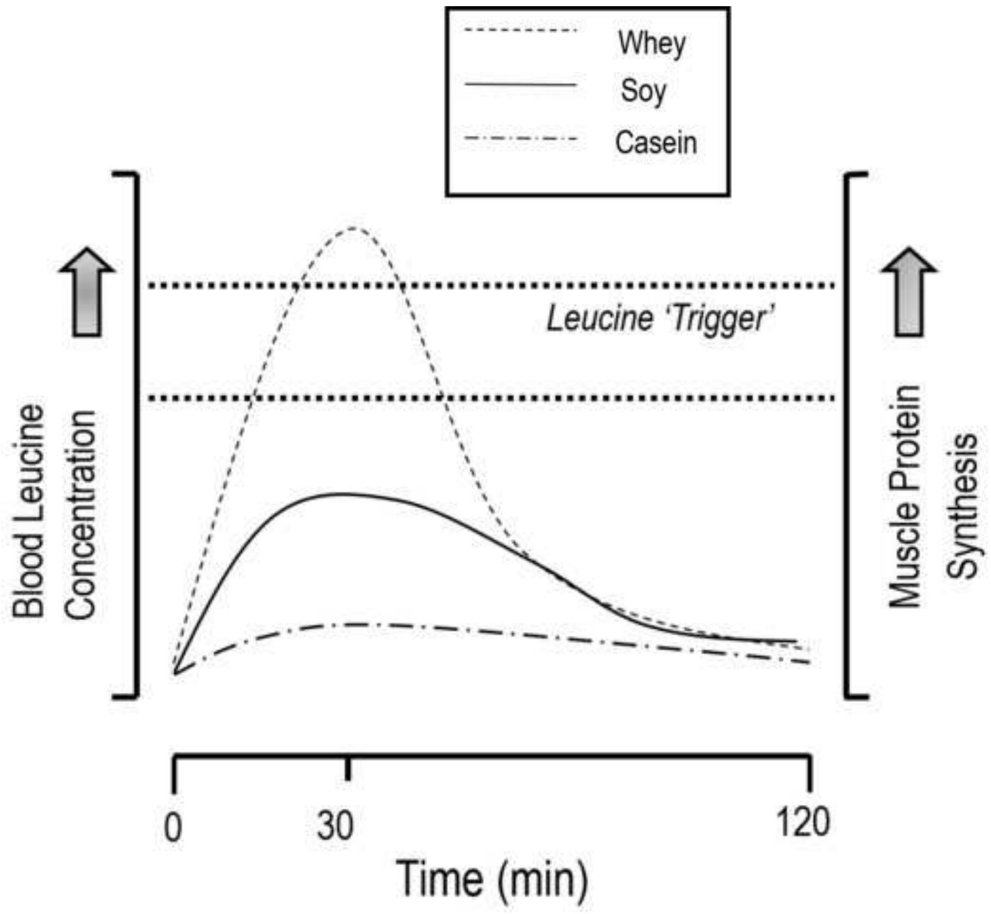
Older (>65 years) men



Moore, Witard *et al* 2015 J Gerontology 70(1):57-62

The conception of the “leucine trigger” hypothesis





Tang et al. 2009, J Appl Physiol 107(3): 987-992

Burd et al. 2019, Sports Medicine 49(1): 59-68

Two recent systematic reviews **challenge** the application of the "leucine trigger" hypothesis

KING'S College LONDON

SYSTEMATIC REVIEW
published: 08 July 2021
doi: 10.3389/fnut.2021.685165

Check for updates

Evaluating the Leucine Trigger Hypothesis to Explain the Post-prandial Regulation of Muscle Protein Synthesis in Young and Older Adults: A Systematic Review

*Gabriele Zaromskyte[1], Konstantinos Prokopidis[2], Theofilos Ioannidis[1], Kevin D. Tipton[3] and Oliver C. Witard[1,4]**

Received: 17 March 2023 | Revised: 20 June 2023 | Accepted: 5 July 2023
DOI: 10.14814/phy2.15775

The Physiological Society | Physiological Reports

REVIEW

Association of postprandial postexercise muscle protein synthesis rates with dietary leucine: A systematic review

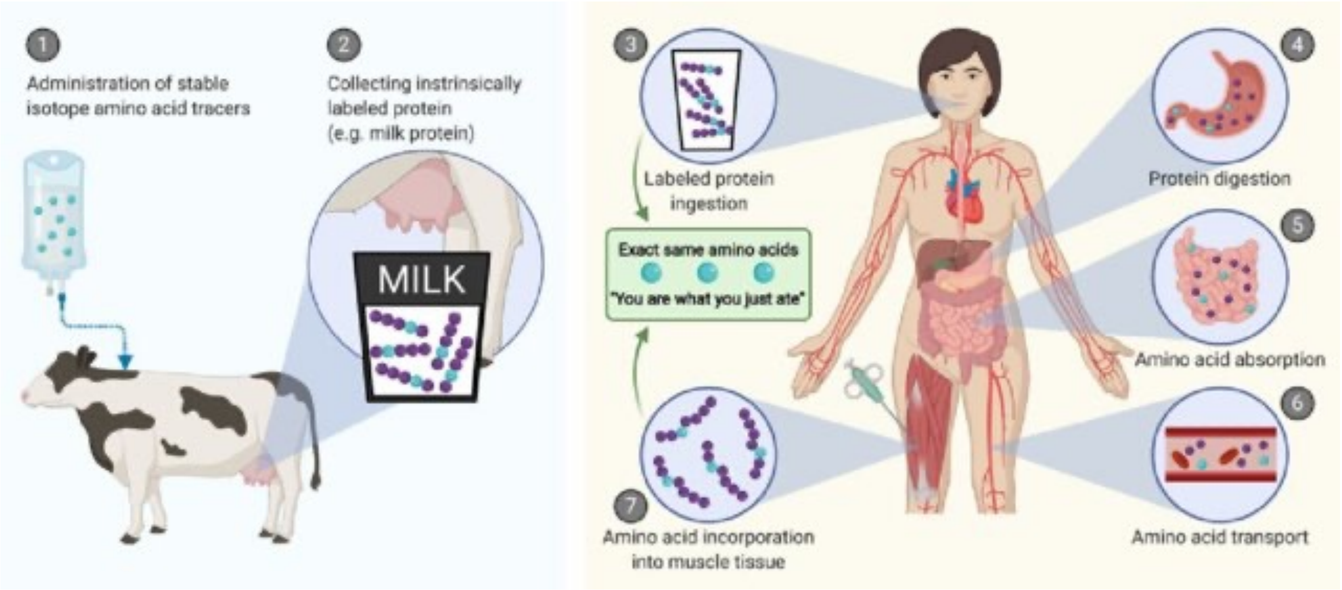
Kiera Wilkinson | Christopher P. Koscien | Alistair J. Monteyne | Benjamin T. Wall | Francis B. Stephens

Zaromskyte et al. 2021, Frontiers in Nutrition 8(8): 685165

Wilkinson et al. 2023, Physiol Rep 11(15): e15775

Comparison of postprandial protein handling after milk or beef ingestion during exercise recovery using intrinsically labelled protein

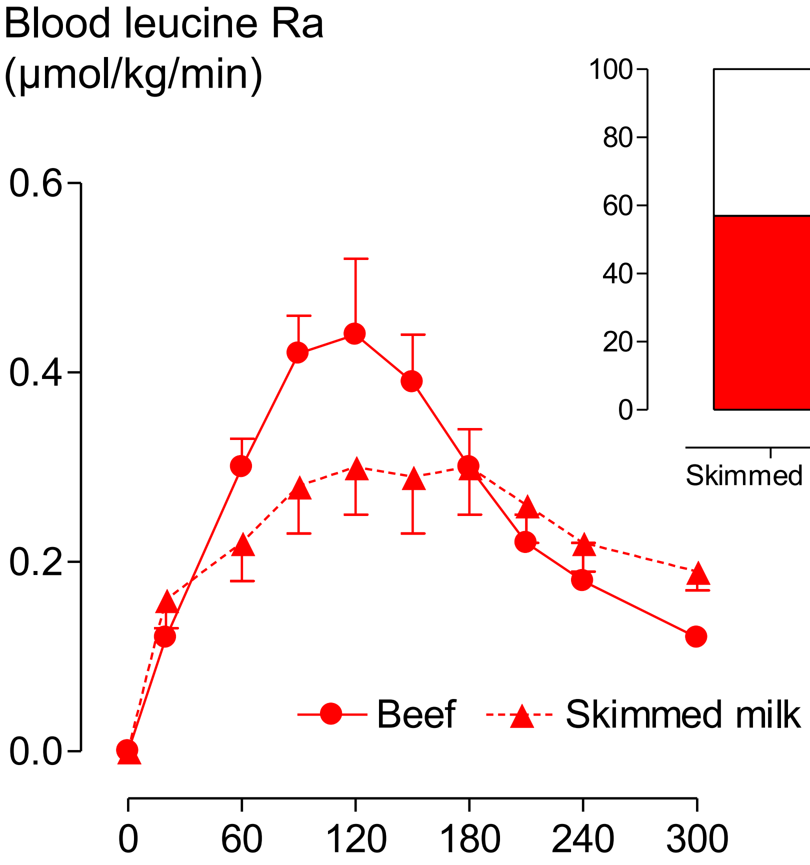
- 12 healthy young (~22 y) males
- Bilateral lower limb resistance exercise
- **350 mL skimmed milk** (247 kcal, 30 g protein, 2.7 g leucine, <1 g fat, 31 g carbohydrate)
- **158 g minced (and grilled) beef patty** (164 kcal, 30 g protein, 2.5 g leucine, 5 g fat, <1 g carbohydrate)
- Amino acid utilization from ingested protein during exercise recovery
- Protein digestion, amino acid absorption, postprandial amino acid availability and MPS

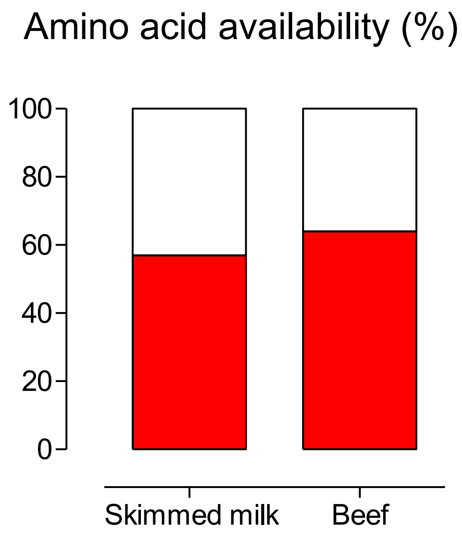


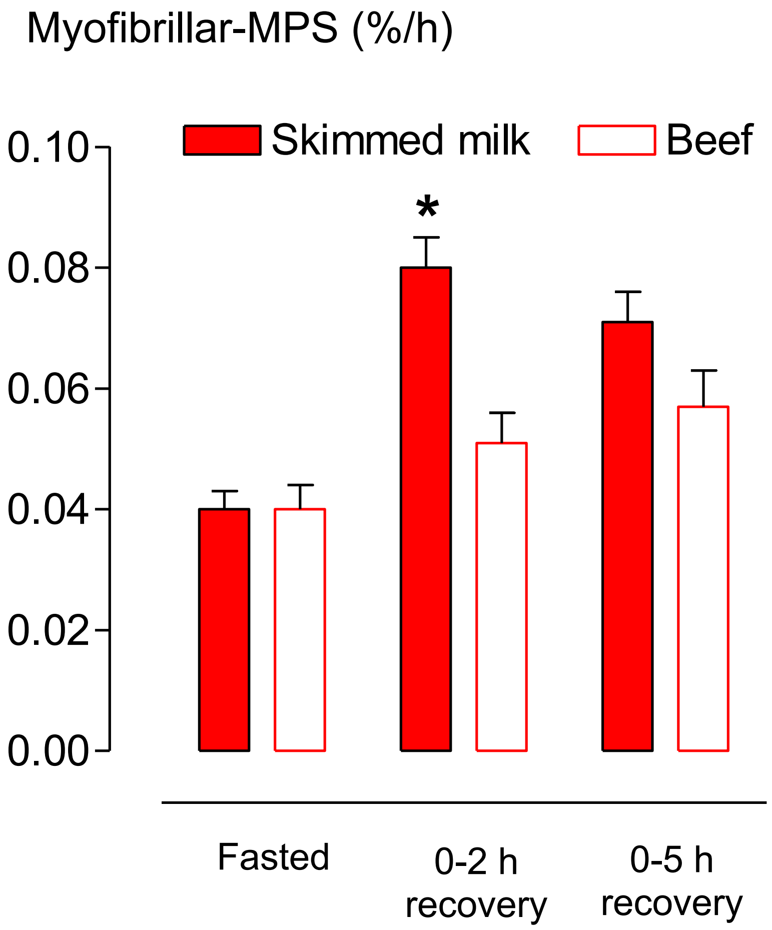
Burd et al. 2015, Am J Clin Nutr 102: 828-836

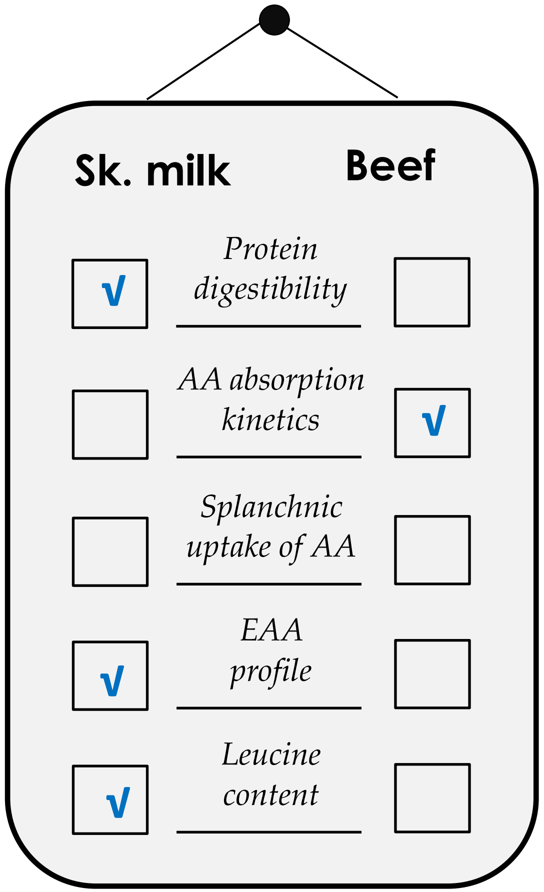
Trommelen et al. 2021, Proceedings of The Nutrition Society 80(2): 1-9

Skimmed milk ingestion stimulates a greater response of MPS during exercise recovery vs. minced beef







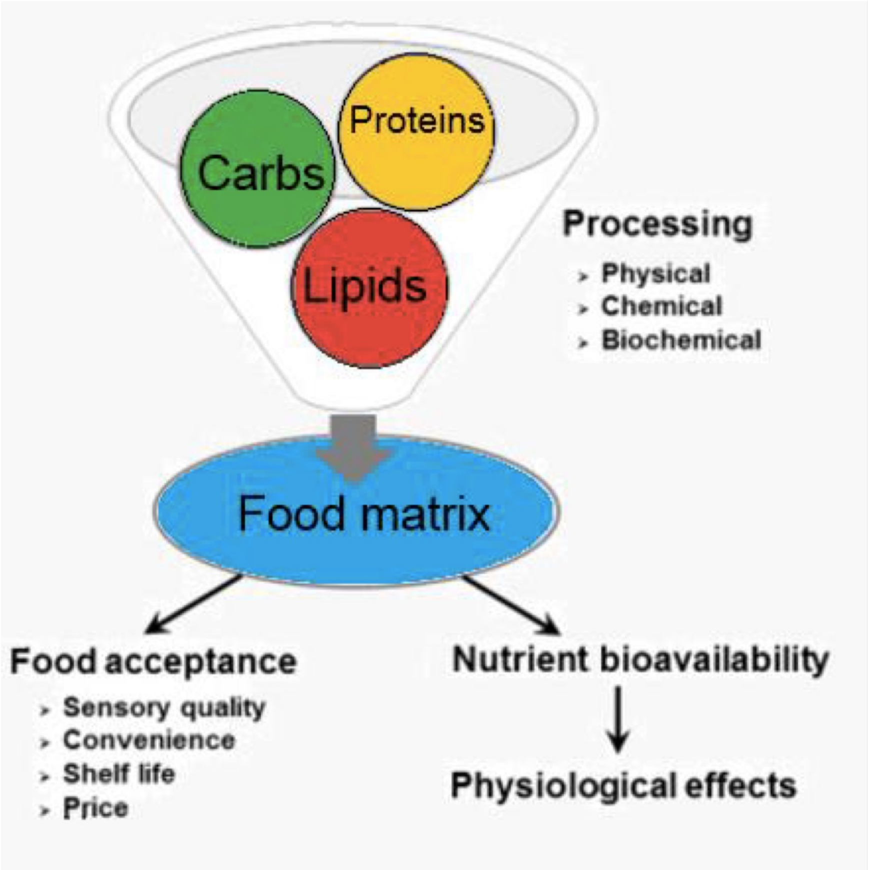


Burd et al. 2015, Am J Clin Nutr 102: 828-836

effect

Defining the (protein) food matrix

- The interactions of nutrient (e.g., protein, vitamins, etc) and non-nutrient components (e.g., physical structure and processing) of food.



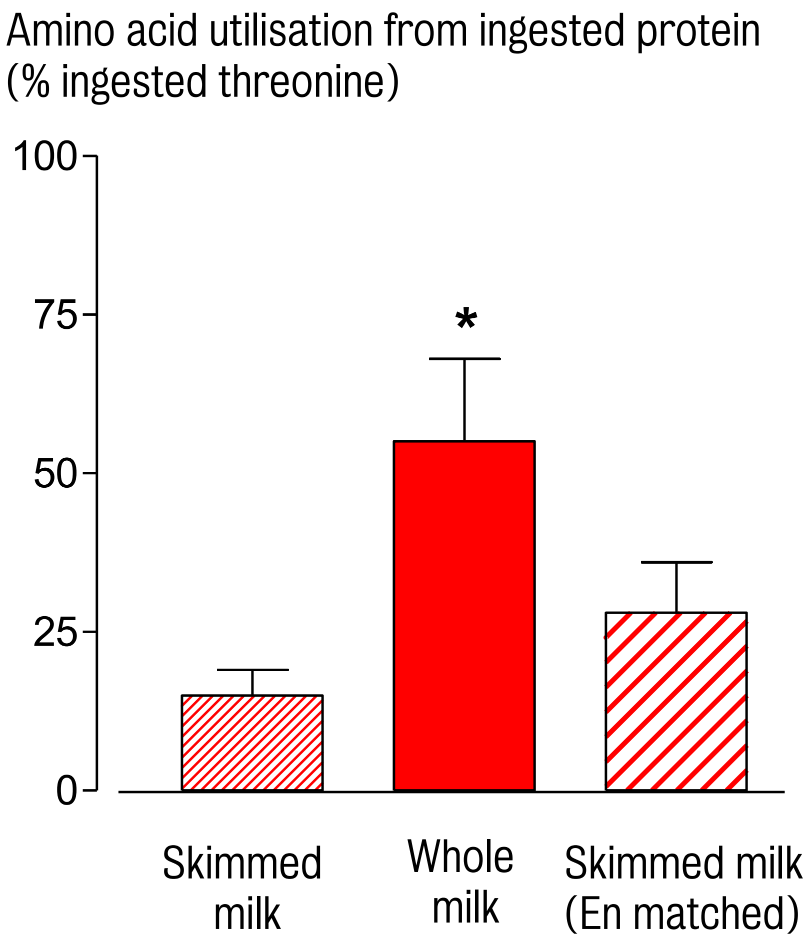
- The food matrix modulates protein digestion and amino acid absorption rates, and the subsequent postprandial release of protein-derived amino acids into the circulation.

Turgeon 2011 Food Hydrcolloids 25(8): 1915-1924

Moughan 2020 J Sci Food Agric 100: 2026-5063

Whole milk ingestion results in the greater utilization of ingested amino acids during exercise recovery compared with **skimmed milk**

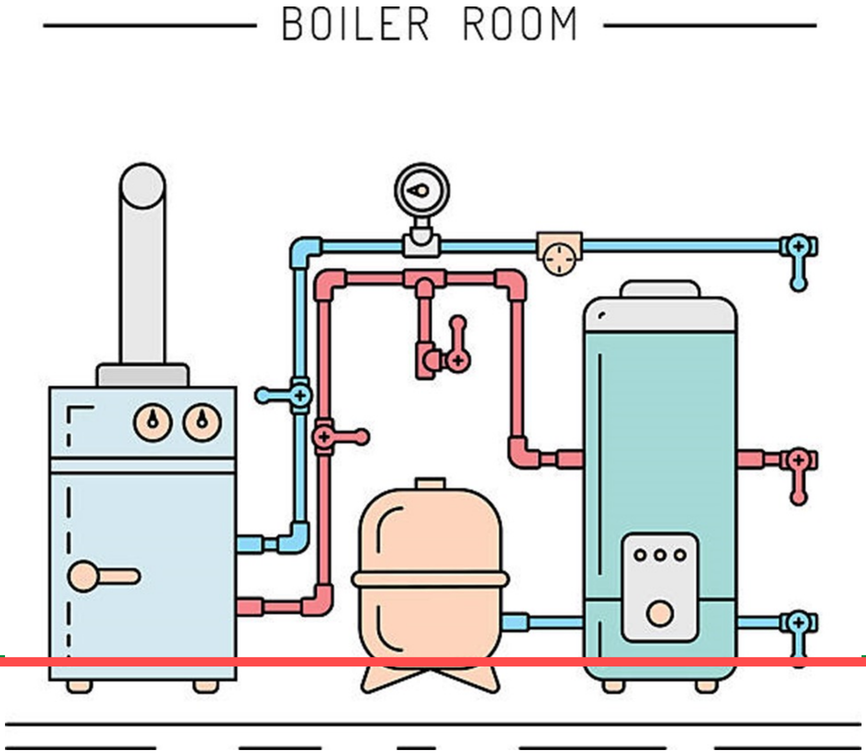
- Healthy young (~24 y) untrained males (n=16) and females (n=8)
- Bilateral lower limb resistance exercise
- **Skimmed milk** (377 kcal, 8.8 g protein, 0.6 g fat, 12 g carbohydrate)
- **Whole milk** (627 kcal, 8.0 g protein, 8.2 g fat, 12 g carbohydrate)
- **Skimmed milk*** (626 kcal, 14.5 g protein, 1.0 g fat, 20 g carbohydrate)
- Amino acid utilization from ingested protein during exercise recovery



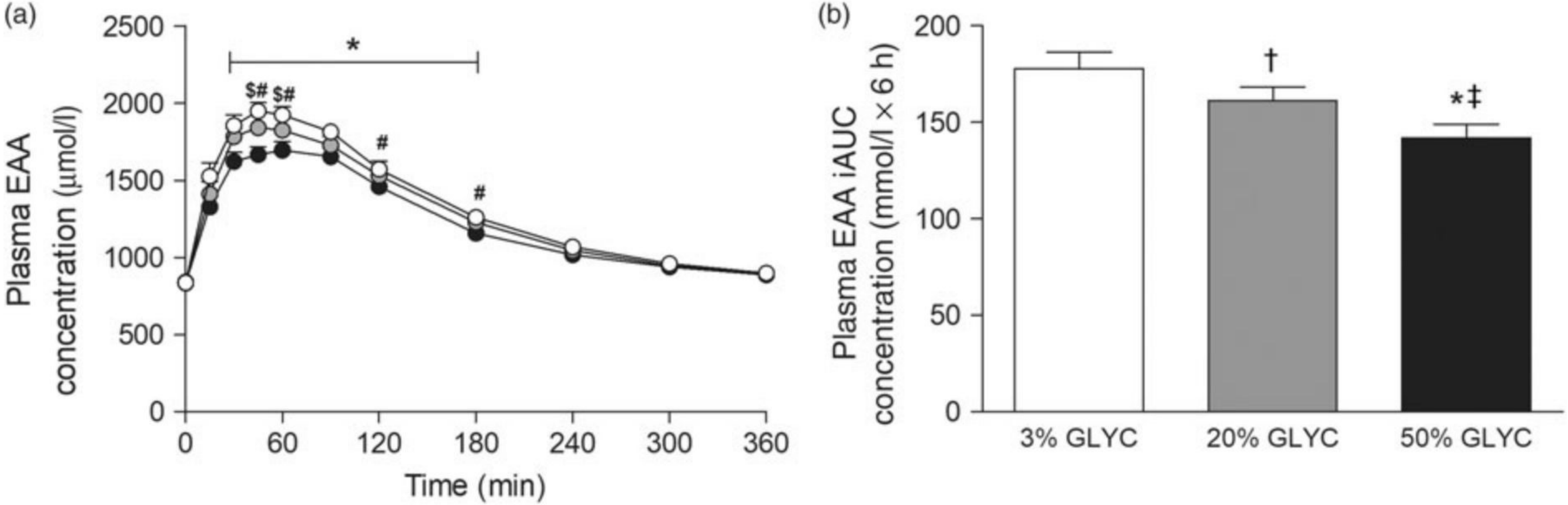
Elliot et al. 2006, Medicine & Science in Sport and Exercise 38(4): 667-74

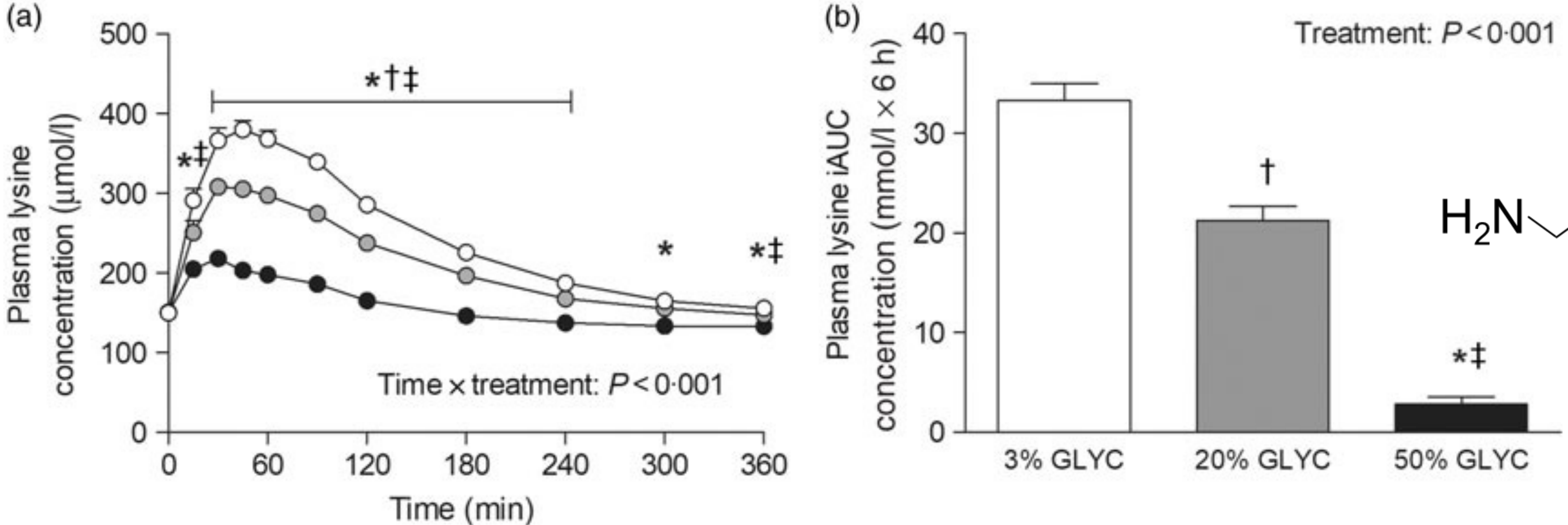
Milk **glycation level** modulates postprandial lysine availability in humans

- 15 healthy young (~26) males
- 40 g **milk powder** (16.8 g protein, 15.6 carbohydrate, 3.6 g fat, 1.6 g minerals)
- **Whey:casein** protein of 60:40
- 3, 20 and 50% glycation levels
- Postprandial plasma amino acid responses

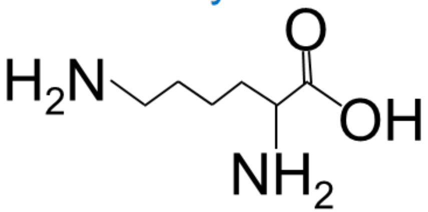


Nyakayiru et al. 2020, Br J Nutr 123: 545-552


(a)
Plasma EAA concentration (μmol/l)
2500
2000
1500
1000
500
0
*
$#
$#
#
#
0
60
120
180
240
300
360
Time (min)
(b)
Plasma EAA iAUC concentration (mmol/l × 6 h)
200
150
100
50
0
†
*‡
3% GLYC
20% GLYC
50% GLYC

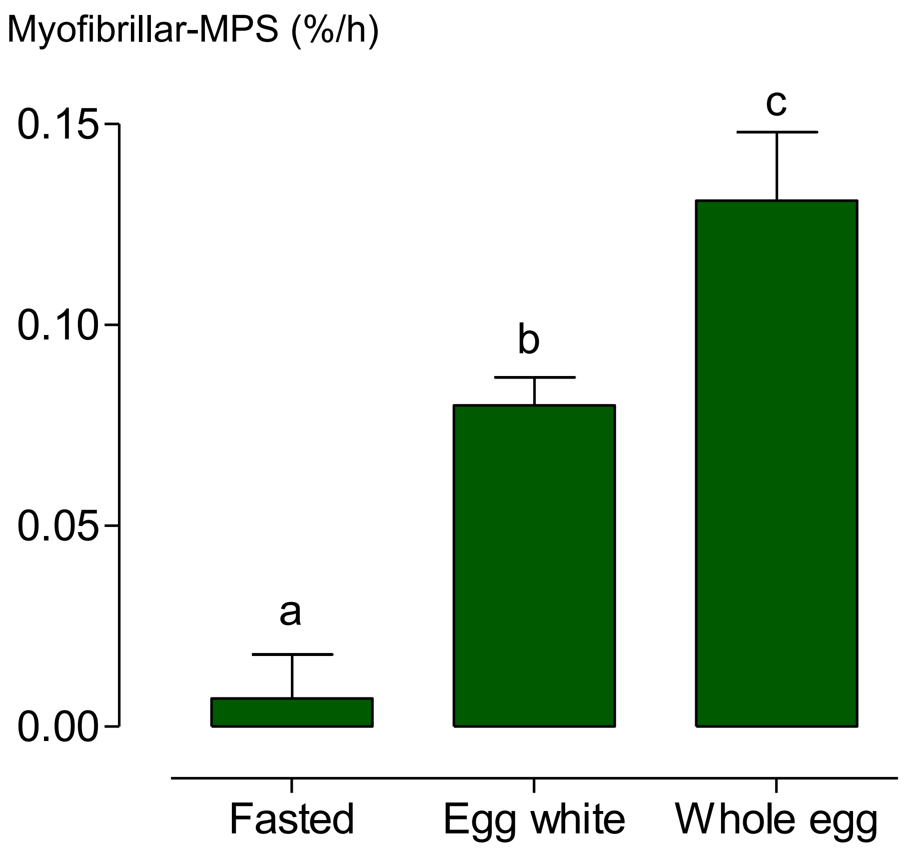

(a)
Plasma lysine concentration (μmol/l)
500
400
300
200
100
0
*†‡
*‡
*
*‡
Time × treatment: P < 0·001
0
60
120
180
240
300
360
Time (min)
(b)
Treatment: P < 0·001
Plasma lysine iAUC concentration (mmol/l × 6 h)
40
30
20
10
0
†
*‡
3% GLYC
20% GLYC
50% GLYC

Lysine


O
H2N
OH
NH2

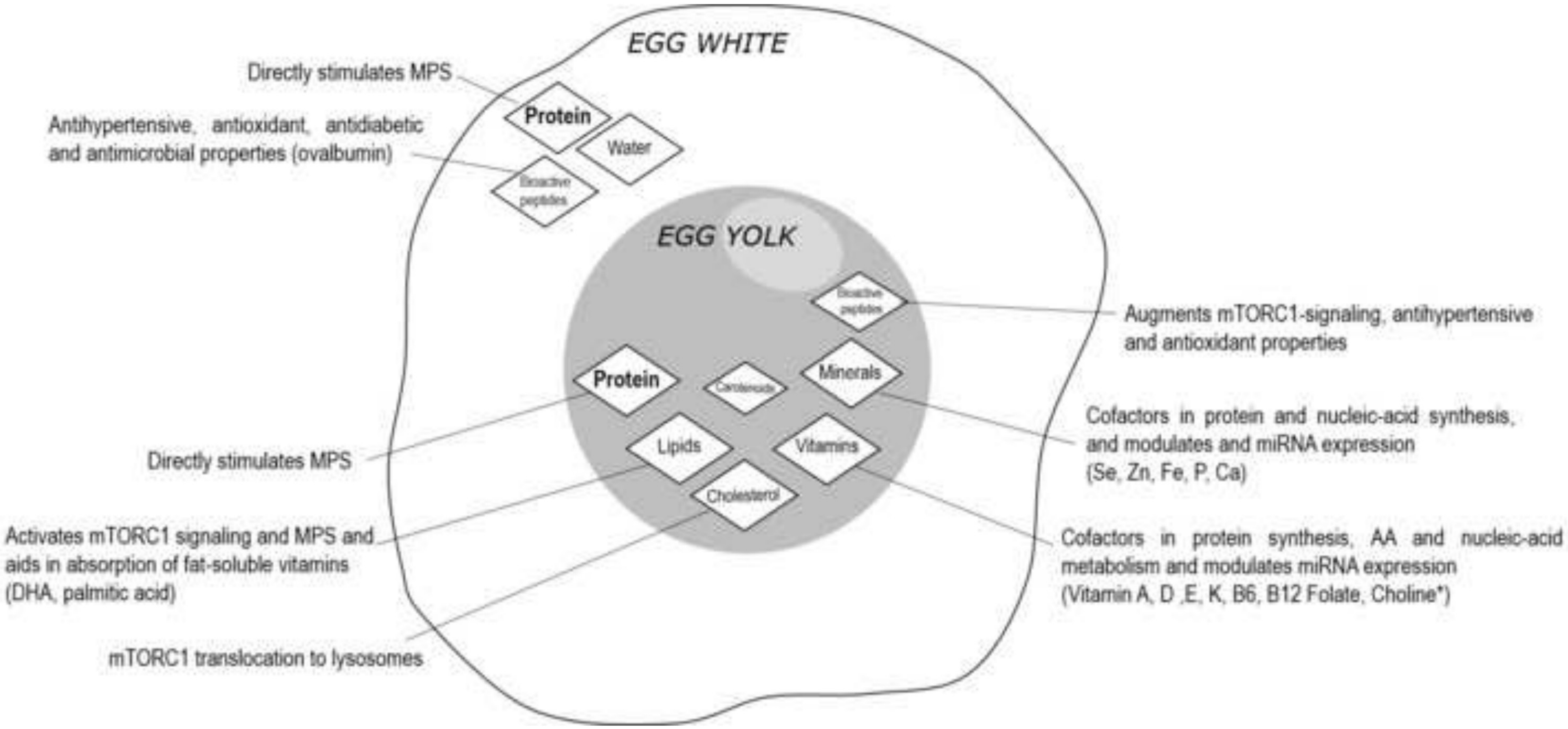
Whole egg ingestion promotes a greater stimulation of MPS than **egg white** during exercise recovery

- 10 resistance-trained young (~21 y) males
- Bilateral lower limb resistance exercise
- 3 **whole eggs** (226 kcal, 18 g protein, 1.6 g leu, 17 g fat)
- **Egg whites** (18 g protein, 1.6 g leu, 0 g fat)
- Amino acid utilization from ingested protein during exercise recovery
- Protein digestion, amino acid absorption, postprandial amino acid availability and MPS



Van Vliet et al. 2017, Am J Clin Nutr 106(6): 1401-1412

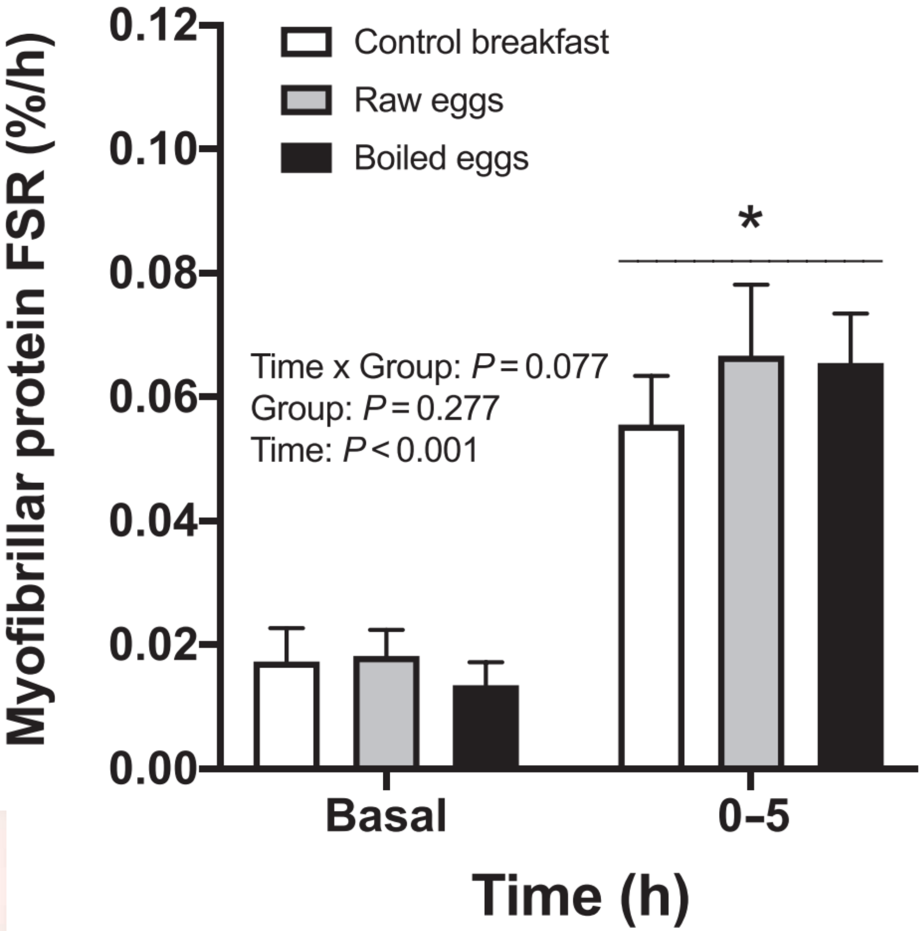
Non-protein components of the whole egg, primarily contained in the yolk, may have a role in regulating MPS



Burd et al. 2019, Sports Medicine 49(1): 59-68

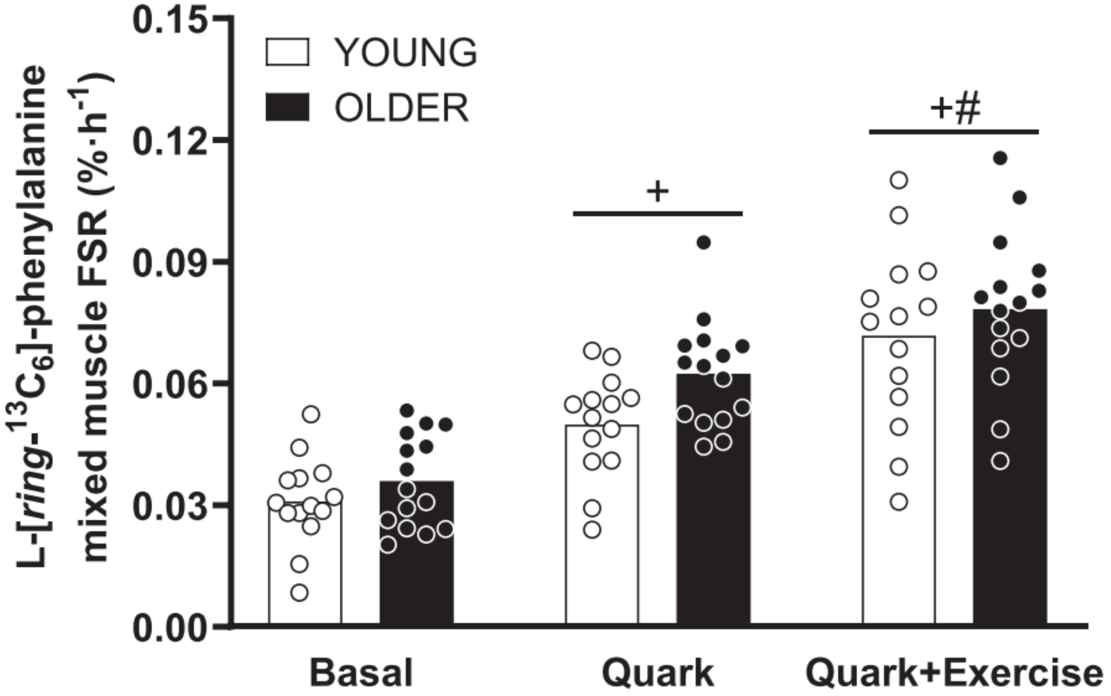
Raw egg ingestion stimulates MPS to a similar extent as boiled eggs during exercise recovery

- 45 resistance-trained young (~24 y) males
- Whole-body resistance exercise
- 5 **raw eggs** (335 kcal, 30 g protein, 23 g fat)
- 5 **boiled eggs** (335 kcal, 30 g protein, 23 g fat)
- Control breakfast of a croissant, 10 g butter and 350 mL orange juice (394 kcal, 5 g protein, 20 g fat, 47 g carbohydrate)
- Postabsorptive and postprandial myofibrillar MPS post-exercise



Quark ingestion stimulates a robust increase in MPS under rested and post-exercise conditions

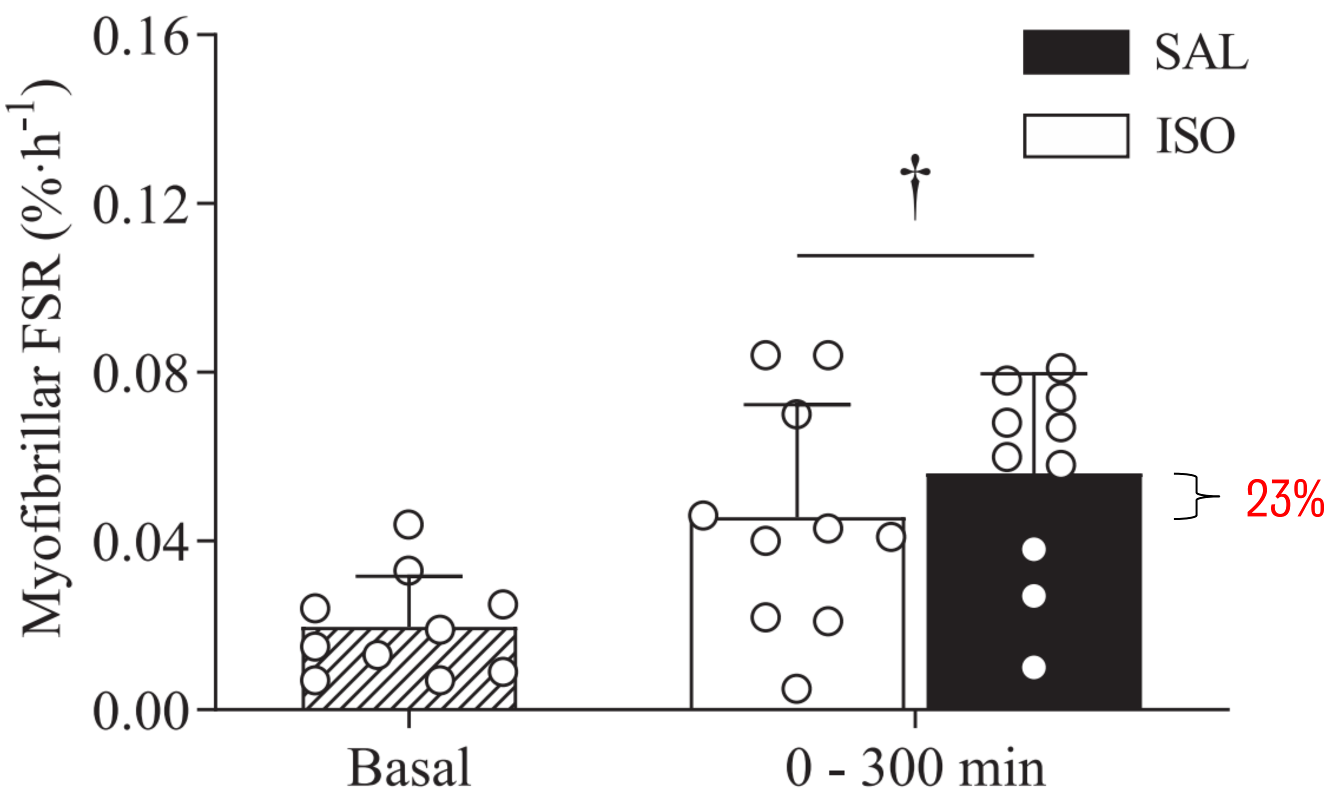
- 14 young (~24 y) and 15 (~73 y) older adults
- Unilateral lower limb resistance exercise
- 291 g **quark** (166 kcal, 30 g protein, 2.9 g leu, 8.2 g carbohydrate, 0.3 g fat)
- Postabsorptive and postprandial mixed MPS at rest and post-exercise



Hermans et al. 2023, J Nutr 155(1): 66-75

Salmon ingestion, within or without its whole-food matrix, results in an equivalent stimulation of MPS post-exercise

- Healthy young (~24 y) males (n=5) and females (n=5)
- Bilateral lower limb resistance exercise
- 99 g **salmon** fillet (20.6 g protein, 1.68 g leucine, 7.6 g fat, 0.44 g EPA, 0.59 g DHA)
- **Salmon-derived isolated nutrients** (20.6 g protein, 1.68 g leucine, 7.6 g fat, 0.45 g EPA, 0.59 g DHA)
- Sous vide preparation (30 min, 63°C internal temperature)
- Postabsorptive and postprandial myofibrillar MPS post-exercise

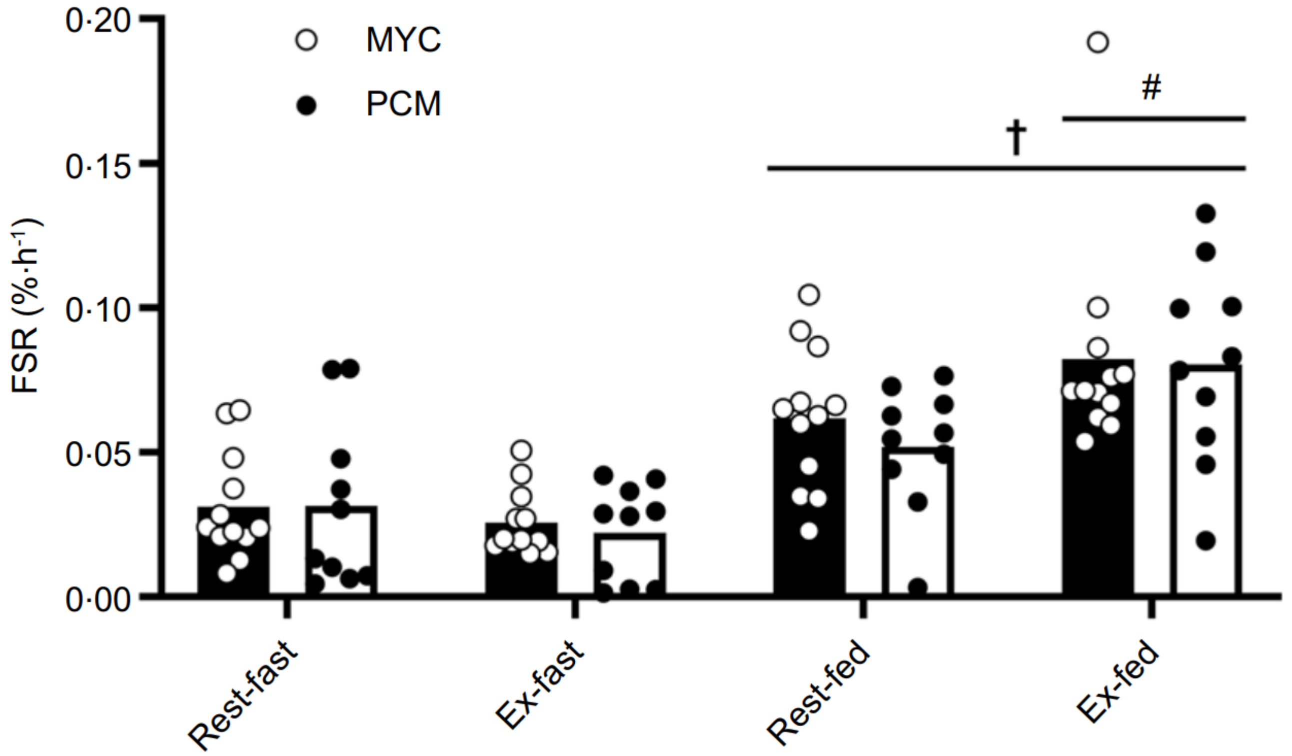


Paulussen et al. 2023, J Nutr 153: 1359-1372

Mycoprotein ingestion within or without its wholefood matrix results in an equivalent stimulation of MPS in young men

KING'S College LONDON

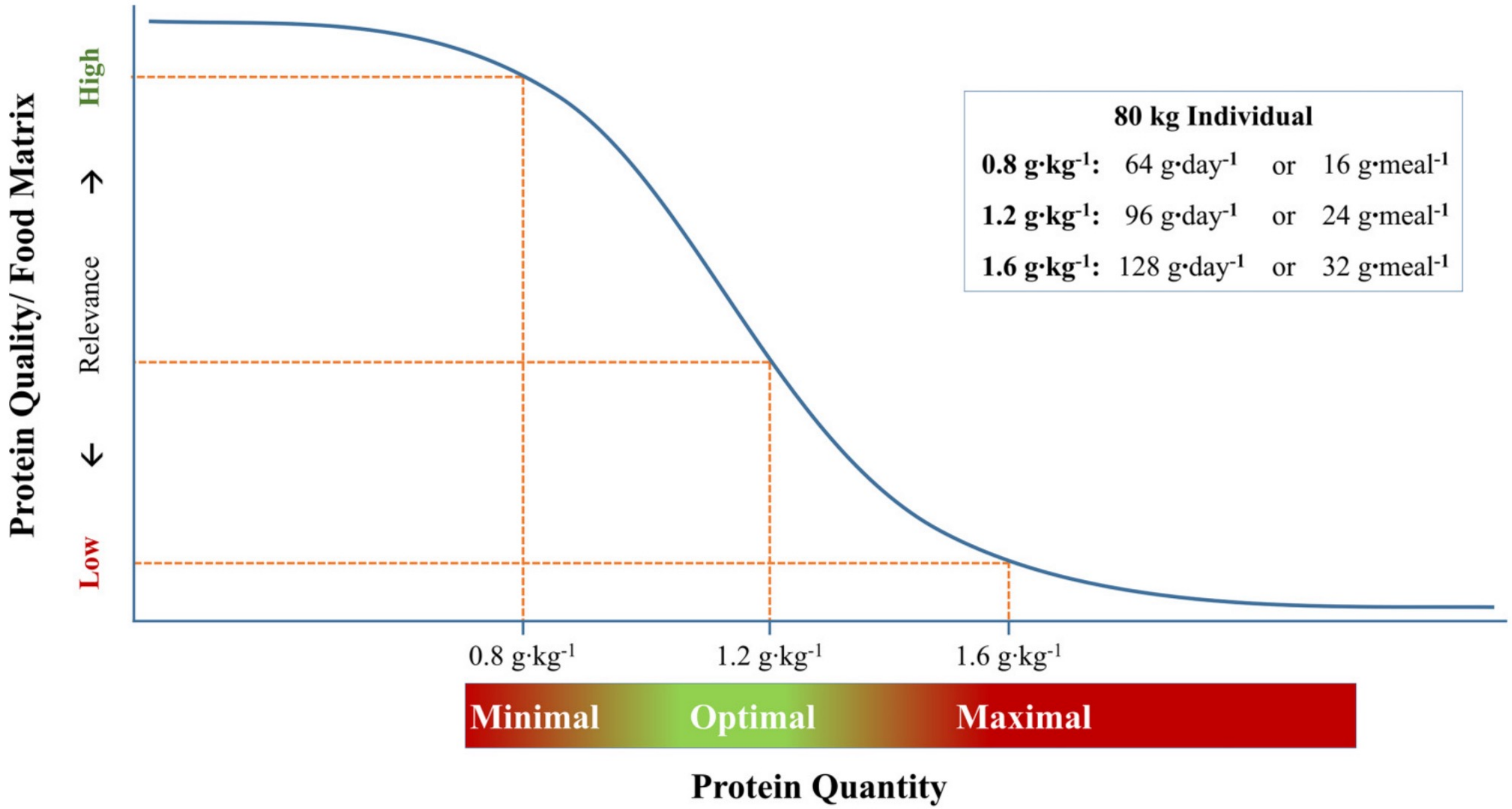
- Healthy young males (n=24)
- Unilateral resistance exercise
- 70 g **mycoprotein** (31.4 g protein, 2.5 g leu)
- 38.2 g **mycoprotein concentrate** (28 g protein. 2.5 g leu)
- Postabsorptive and postprandial myofibrillar MPS at rest and post-exercise



Quorn

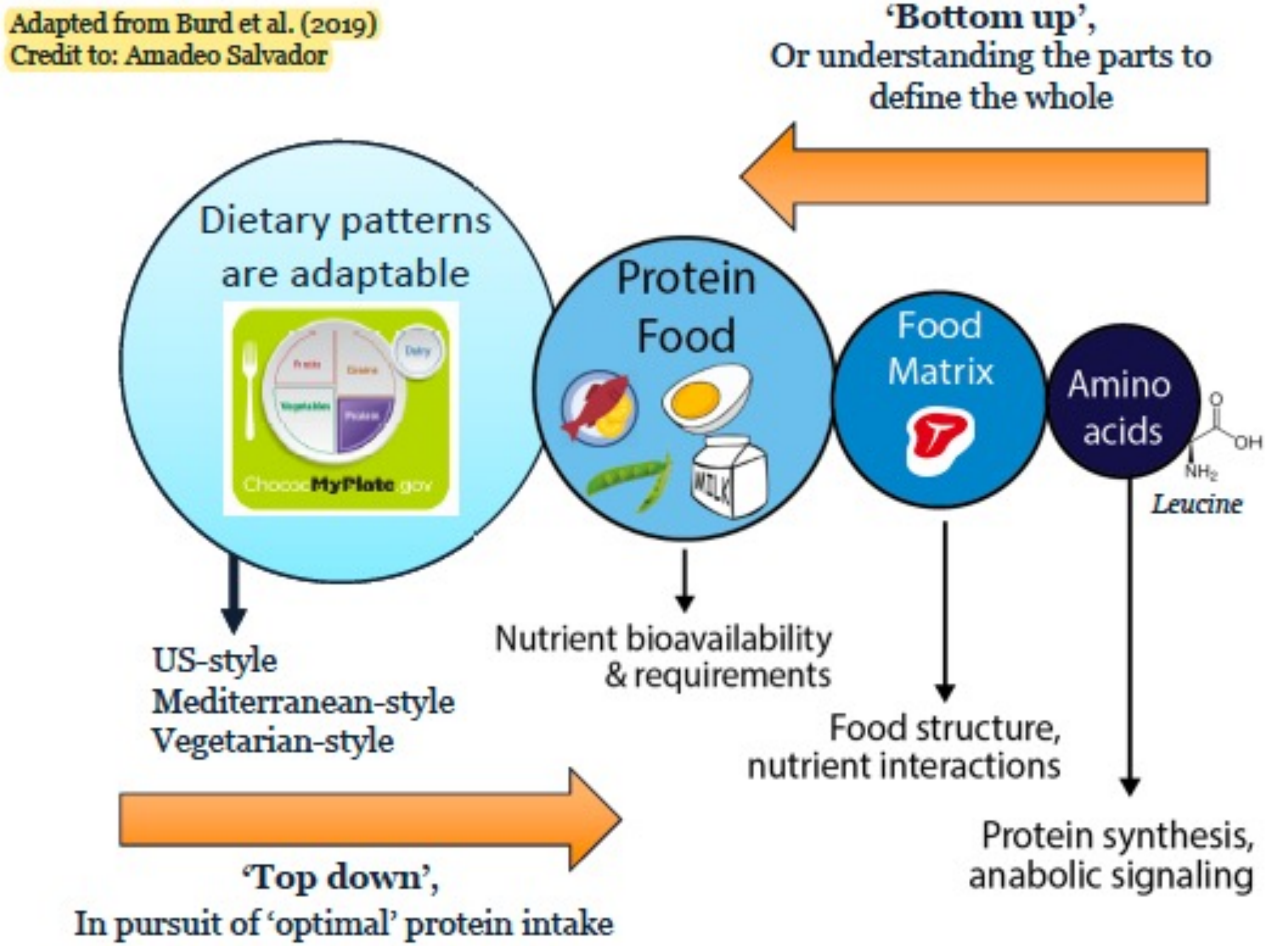
West et al. 2023, Br J Nutr 130: 20-32

Higher relevance of food matrix at low-moderate protein intakes that declines with increasing intakes



Barnes 2023 Br J Sp Med 52(6);376-384

Redefining protein recommendations based on the food matrix effect … food for thought (pun intended!)



Burd et al. 2019, Frontiers in Nutrition 6(83)

Concluding statements

1. The ingestion of protein-dense whole foods stimulate a robust MPS response despite eliciting a prolonged rather than rapid rise in leucine availability during exercise recovery

2. The "leucine trigger" hypothesis may be more relevant after the ingestion of isolated protein sources rather than whole food protein sources

3. The ingestion of whole foods and the associated (non)nutrient-nutrient interactions facilitate a greater MPS response than the individual actions from each individual food component (or sum of its parts!)

4. A paradigm shift is needed in human nutrition to re-define protein recommendations based on commonly consumed protein-rich foods

Acknowledgements

Maastricht
Luc Van Loon
Jorn Trommelen
PhD students and postdocs

University of Illinois
Nick Burd
PhD students and postdocs

University of Toronto
Dan Moore
PhD students and postdocs

McMaster University
Stu Phillips
PhD students and postdocs

University of Exeter
Ben Wall
Francis Stephens
PhD students and postdocs

Many others ...

Many others ...

Hvala!