



History Pitching Success Story: ***In vitro* Digestibility and Protein Quality** **Assessment-** **The example of edible insects**

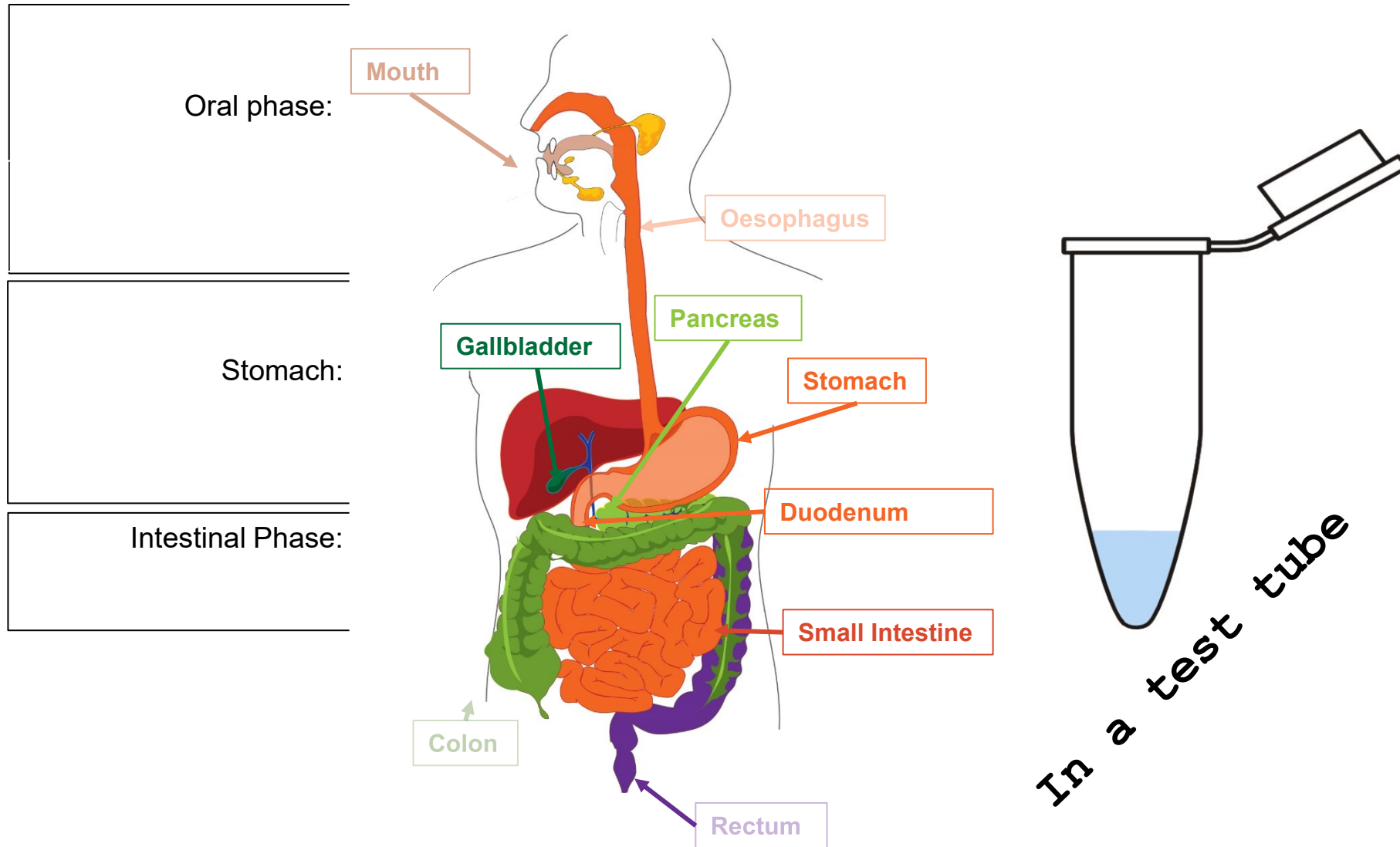


Lotti Egger, Laila Hammer, Raquel Sousa, and Reto Portmann

*AGRO FOOD innovation forum, History Pitching Success Story
Techno Park, 19th September 2023*



Starting point 2011: The Human digestion – in a test tube



History Pitching Success Story: *In vitro* Digestibility and Protein Quality Assessment- The example of edible insects, Swiss Food Research, Zürich, 19th September 2023

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Our goals for the use of *in vitro* digestion

Protein declaration in EU is based on quantity, but...



Limiting
essential
amino acid

LYS = Lysin / MET = Methionin
ILE = Isoleucin / LEU = Leucin / PHE = Phenylalanin
THR = Threonin / TRP = Tryptophan / VAL = Valin

www.sge-ssn.ch/protein-2022.

...protein sources are compared based on quality (DIAAS, FAO 2013)



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2014-2019: INFOGEST - International harmonized protocol

In vitro digestion protocol

Step	Step	
5 d 	Preparation	
	• Perform enzyme activity and bile assays	
	• Prepare SSF, SGF and SIF stock solutions	
1 d 	1	
	• Perform pH-test adjustment experiment	
	Oral phase	2
		• Mix Food with SSF (1:1, (wt/wt))
		• Include CaCl ₂ (1.5 mM in SSF)
		• Add salivary amylase, if necessary (75 U/mL)
	Gastric phase	4
		• Incubate while mixing (2 min, 37 °C, pH 7)
		17, 18
		• Mix oral bolus with SGF (1:1 (vol/vol))
	Intestinal phase	13
		• Include CaCl ₂ (0.15 mM in SGF)
19		
• Add pepsin, gastric lipase (2,000, 60 U/mL)		
Sampling	20, 21	
	• Incubate while mixing (2 h, 37 °C, pH 3.0)	
	22–24	
	• Mix gastric chyme with SIF (1:1 (vol/vol))	
PAPER	25, 26	
	• Include bile (10 mM bile salts)	
	27	
	• Include CaCl ₂ (0.6 mM in SIF)	
Protocol	28	
	• Add pancreatin (trypsin activity 100 U/mL)	
	29	
	• Incubate while mixing (2 h, 37 °C, pH 7.0)	

Food & Function

PAPER

INFOGEST

cost

INFOGEST static in vitro simulation of gastrointestinal food digestion

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A standardised static in vitro digestion method suitable for food – an international consensus†

M. Minekus,¹ M. Alvinger,² P. Alvito,³ S. Ballance,⁴ T. Bohn,⁵ C. Bourrieu,⁶ F. Carrière,⁷ R. Boutrou,⁸ M. Corredig,⁹ D. Dupont,¹⁰ S. C. Dufour,¹¹ L. Egger,¹² M. Golding,¹³ S. Karakaya,¹⁴ B. Kirkhus,¹⁵ S. Le Feunteun,¹⁶ U. Lesmes,¹⁷ A. Macierzanka,¹⁸ A. Mackie,¹⁹ S. Marze,²⁰ D. J. McClements,²¹ O. Menard,²² I. Recio,²³ C. N. Santos,²⁴ R. P. Singh,²⁵ G. E. Vegarud,²⁶ M. S. J. Wickham,²⁷ W. Weitschies²⁸ and A. Brodtkorb²⁹

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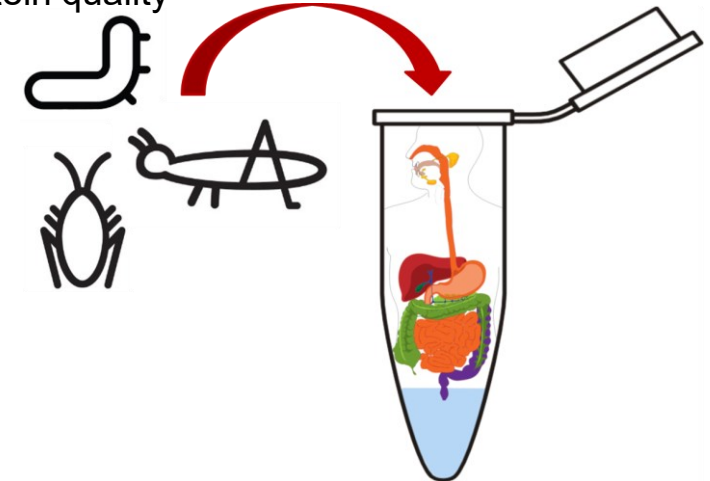
Minekus, M. et al. (2014), A standardised static in vitro digestion method suitable for food – an international consensus, Food Funct. Brodtkorb, Egger, Recio et al. (2019). INFOGEST static in vitro simulation of gastrointestinal food digestion, Nature Protocols



Call 2019 – July 10, 2019 – Project 1906

Protein quality of edible insects
 Charlotte Egger and Reto Portmann, Agroscope
 Philipp Egli, Insekerei GmbH

Digestibility of insect proteins as indicator for protein quality



Project submission 2019

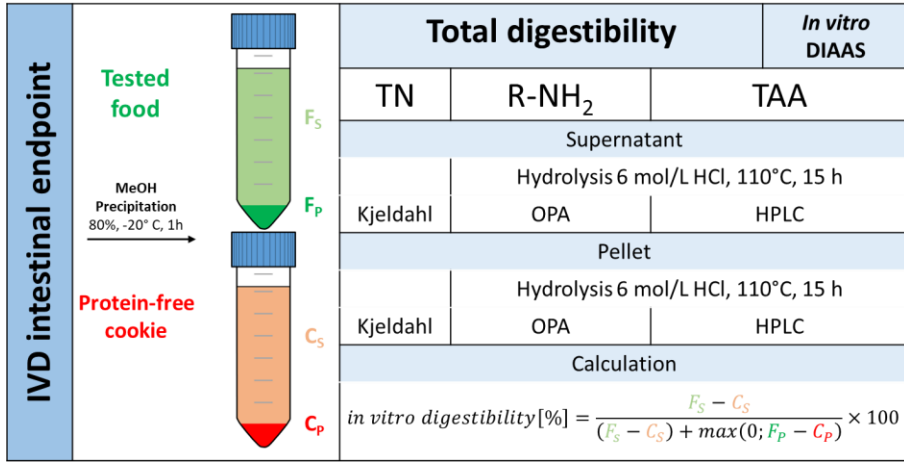
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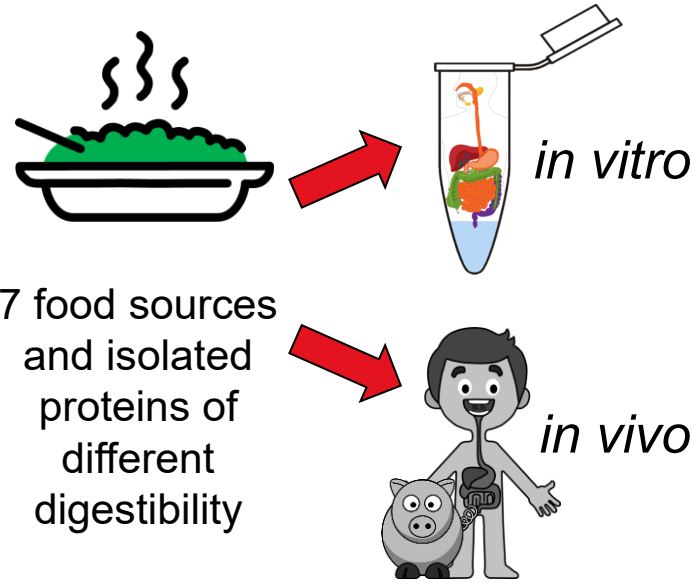


2022: *In vitro* digestibility and DIAAS workflow: validation

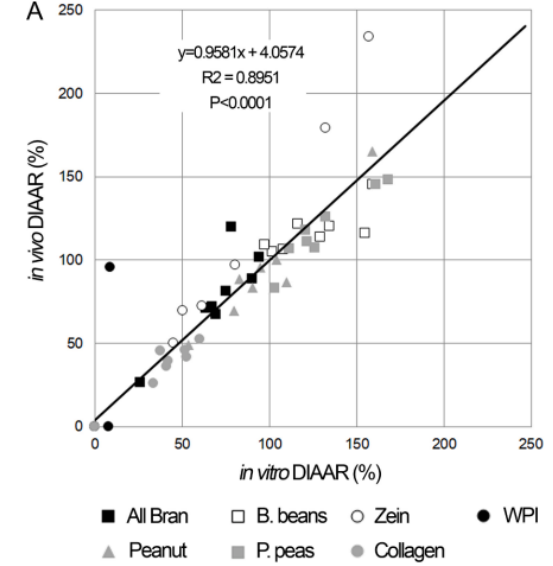
Workflow development



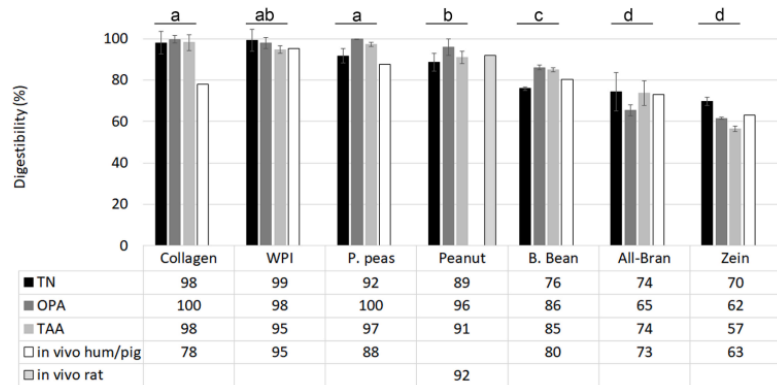
Validation *in vivo* / *in vitro*



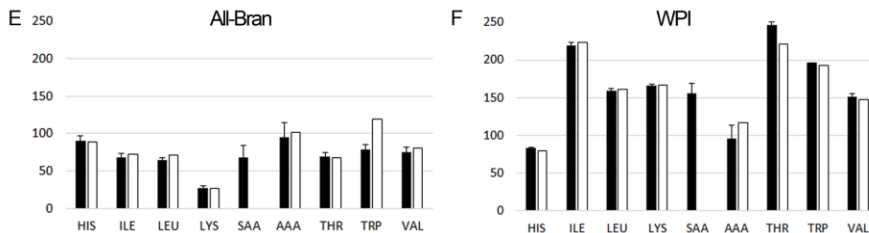
Correlation: 0.96



digestibility



DIAAS



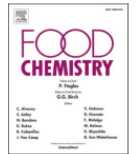
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journal homepage: www.elsevier.com/locate/foodchem



In vitro digestibility of dietary proteins and *in vitro* DIAAS analytical workflow based on the INFOGEST static protocol and its validation with *in vivo* data

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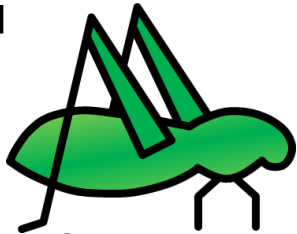


2023: *In vitro* digestibility and DIAAS of mealworm and cricket in comparison to chicken meat

Edible insects

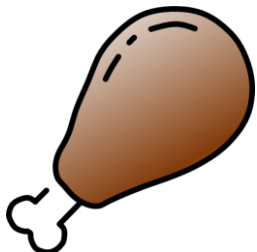


Mealworm

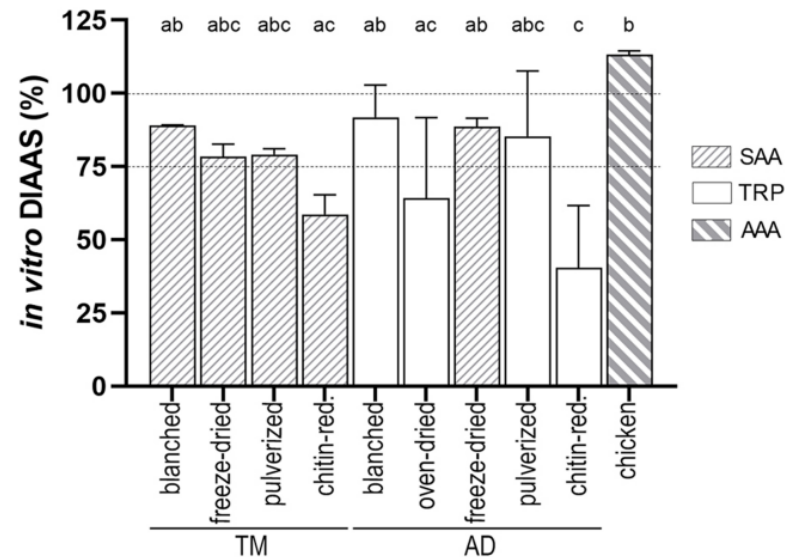
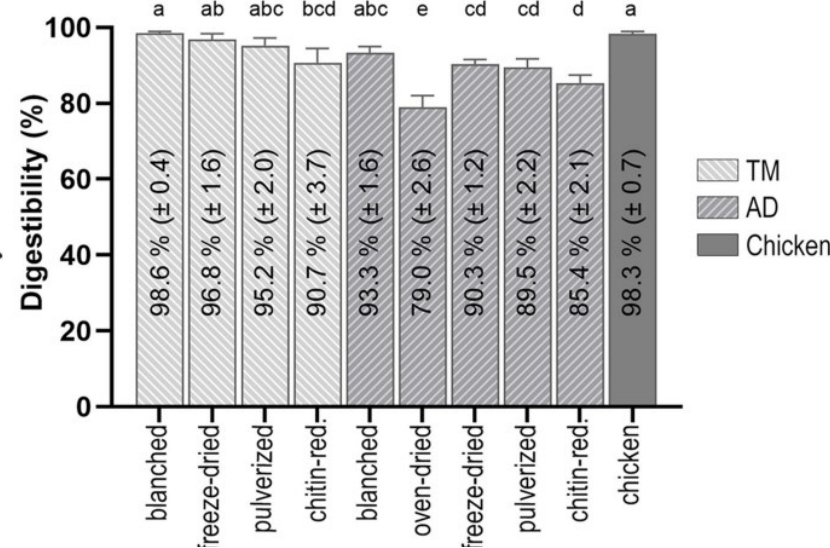
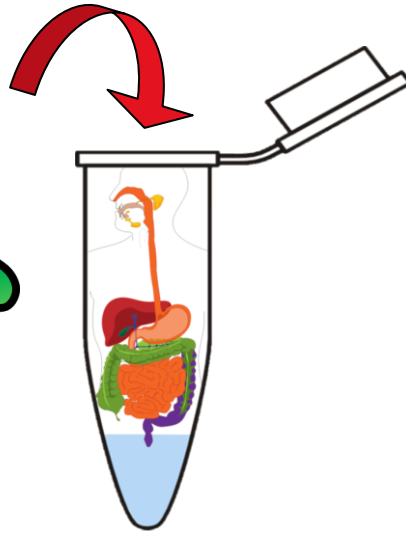


Cricket

Control food



Chicken meat



ORIGINAL RESEARCH article

Front. Nutr., 03 July 2023
 Sec. Nutrition and Food Science Technology
 Volume 10 - 2023 |
<https://doi.org/10.3389/fnut.2023.1150581>

This article is part of the Research Topic
 Food of the Future: Insects
[View all 5 Articles >](#)

Mealworm larvae (*Tenebrio molitor*) and crickets (*Acheta domesticus*) show high total protein *in vitro* digestibility and can provide good-to-excellent protein quality as determined by *in vitro* DIAAS

Laila Hammer^{1,2,3} Diego Moretti² Lychou Abbühl-Eng¹ Pabiraa Kandiah¹
 Nikolin Hilaj¹ Reto Portmann^{1*} Lotti Egger^{1**}



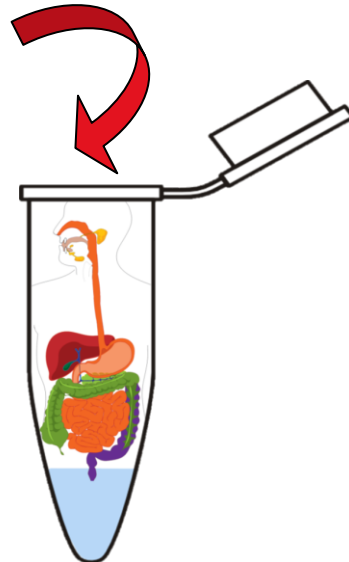
In collaboration with FFHS



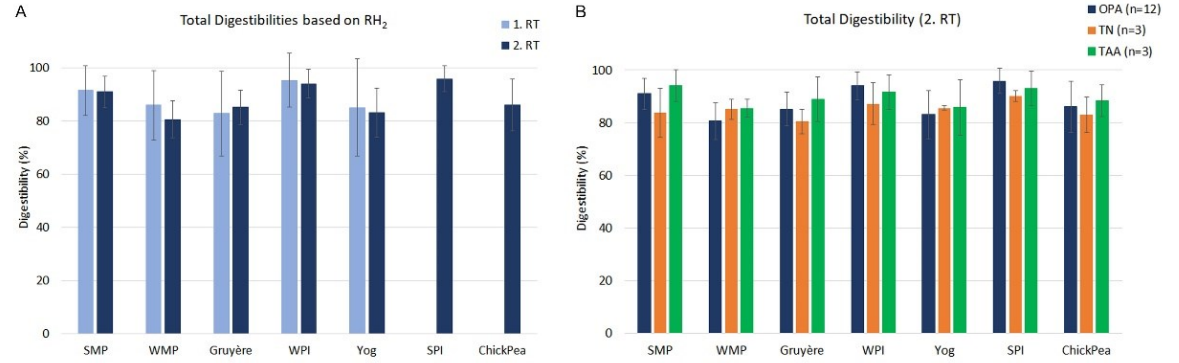
2020 – 2025? - Standardization of method within IDF and ISO



In vitro digestion of 5 Dairy products: skim milk powder, whole milk powder, whey protein isolate, yoghurt, cheese and 2 Plant-based products: soy protein isolate, chick pea



digestibility



repeatability

		2nd RT							
		Average	SMP	WMP	Gru	WPI	Yog	SPI	ChickPea
N			11	11	11	12	11	12	10
SD	6.9	6.0	7.1	6.4	5.4	9.2	4.8	9.7	
SEM	2.1	1.8	2.1	1.9	1.5	2.8	1.4	3.1	
S _r	8.6	9.5	11.7	10.3	6.2	7.7	4.7	10.1	
S _{rRel}	9.9	10.4	14.5	12.1	6.6	9.3	4.9	11.7	
r (sr*2.8)	24.1	26.5	32.7	28.9	17.3	21.6	13.1	28.3	

ISO #####2023(E)
IDF ###:2023(E)



Milk and milk products - *In vitro* digestion protocol for the analysis of protein digestibility and *in vitro* digestible indispensable amino acid score (DIAAS)

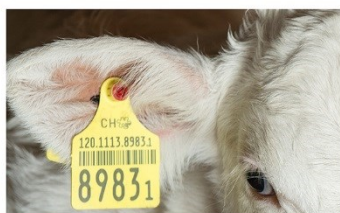
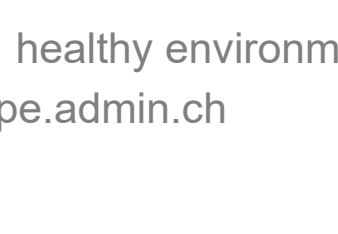
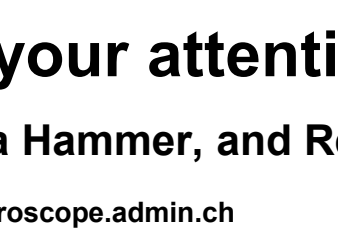
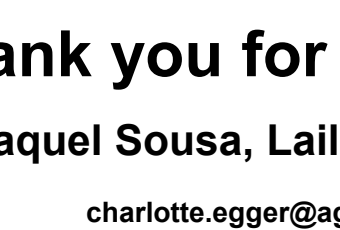
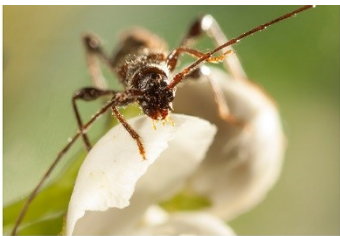
ISO/TC 34/SC 5
Date: 2023-09-07
Secretariat : NEN



Summary

A validated and standardized *in vitro* workflow for protein digestibility and protein quality assessment (DIAAS)

- Helps as screening tool in the development of new products
- Is needed to compare protein quality of traditional and novel sources
- Can be used to support product claims for protein sources



Thank you for your attention

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Agroscope good food, healthy environment

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