Comparing nutritional and digestibility aspects of sustainable proteins using the INFOGEST digestion protocol

Renata M.C. Ariëns, Shanna Bastiaan-Net, Dianne B.P.M. van de Berg-Somhorst, Karim El Bachrioui, Anouk Boudewijn, Ron T.M. van den Dool, Govardus A.H. de Jong, Harry J. Wichers and Jurriaan J. Mes

Introduction

Protein quality is determined based on amino acid composition and digestibility. The current standards for protein digestibility are still animal-based PDCAAS or DIAAS analysis. Food research should use animal free models wherever possible to contribute to a more sustainable food system.

We developed an extension on the harmonized INFOGEST static digestion protocol facilitating the characterization of digested proteins and peptides that can be adsorbed by the small intestine. The added cross-flow filtration separates the digest in a filtrate and retentate fraction. By subsequent analysis of individual amino acids in digest, filtrate and retentate one can study mass balance (Table 2). Those that pass the mass balance quality control can then be studied for their digestibility (Table 3). Subsequently, this data can be used to calculate *in vitro* DIAAS values (Table 4). Here, we used this new method for the analysis of two established protein concentrates (whey and pea) and several alternative protein sources.

Material & Methods

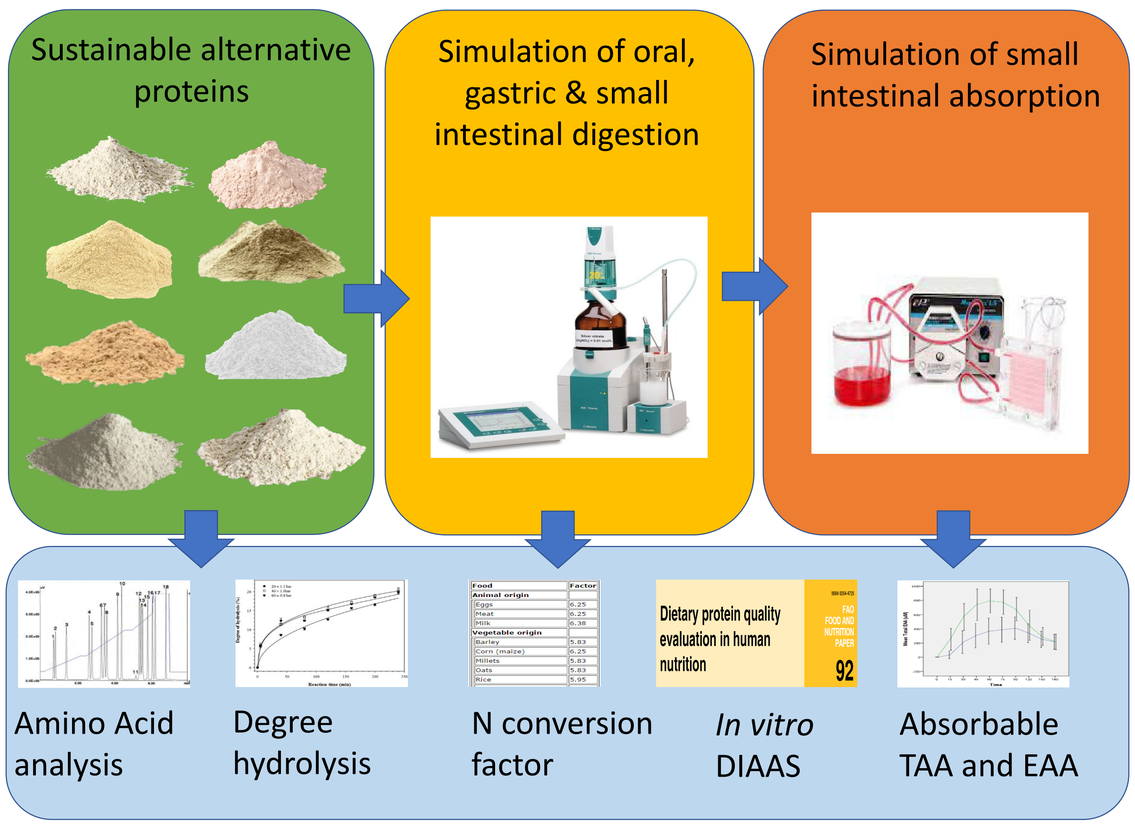

Fig 1. Infographic on used methods and analysis of the protein sources. The harmonized INFOGEST protocol [1] was performed by pHstat. The ultra filtration was performed by 5,000 MW Hydrosart Vivaflow filter (VF05H1; Sartorius AG, Gottingen, Germany). More details and additional study results are published [2].

Table 1: Sustainable protein concentrates sources used in this study.

Abbreviation	Full name	Protein %
BPC	Bovine plasma concentrate (*Bos taurus*)	72
CPC	Corn protein concentrate (*Zea mays,* kernels)	83
LMC2	Lesser mealworm concentrate 2 (*Alphitobius diaperinus*)	68
MP	MycoProtein (*Fusarium venenatum,* mycelium)	54
NPP	Experimental Pea protein concentrate (*Pisum sativum,* yellow peas)	80
TPP1	Potato protein concentrate 1 (*Solanum tuberosum,* tubers)	95
WPC	Whey protein concentrate (*Bos taurus*)	74
YPC	Yeast protein concentrate (*Saccharomyces cerevisiea*)	84

Results

Table 2: Total AA values for the protein sample digests, filtrates and retentates and the calculated total recovery and recovery of filtrate.

We have set a mass balance recovery to be at least 85% to pass the data for further analysis. MP did not pass this quality control and presented data for TID and *in vitro* DIAAS are therefore not reliable.

Protein Source	Digest (g)	Retentate (g)	Filtrate (g)	Total recovery (%)	Recovery filtrate (%)
BP	11.39	1.89	9.64	101	85
CPC	11.21	1.73	8.27	89	74
LMC2	7.54	1.10	5.39	86	71
MP	11.76	2.83	5.90	74	50
NPP	10.42	1.88	7.69	92	74
TPP1	9.40	1.57	6.56	86	70
WPC	11.52	1.86	9.68	100	84
YPC	11.03	1.73	8.71	95	79

Table 3. Single AA True Ilial Digestibility score. Data are expressed as mean.

Protein sources	His	Thr	Val	Lys	Ile	Trp	Leu	SAA	AAA	EAA	TAA
BPC	93.7	89.4	92.2	89.6	92.9	95.5	90.5	70.8	100.9	90.6	89.1
CPC	72.6	74.2	77.2	79.3	78.4	87.5	77.8	64.3	130.8	82.5	75.5
LMC2	75.5	70.7	74.7	75.2	76.0	85.9	73.4	93.5	74.2	77.7	76.8
MP	51.2	44.8	49.5	48.5	50.1	91.5	48.6	60.3	68.5	57.0	52.2
NPP	75.5	77.1	77.5	79.3	79.4	82.0	77.5	73.2	98.3	80.0	76.5
TPP!	75.4	70.2	70.7	75.2	72.2	80.3	70.9	87.6	98.7	77.9	73.0
WPC	96.4	83.3	88.2	87.3	90.2	95.9	91.8	97.4	99.3	91.1	89.9
YPC	84.5	84.5	83.5	88.3	83.1	84.7	83.2	79.6	100.7	85.8	82.9

Table 4: *In vitro* DIAAS calculation expressed as mean based on FAO values for adults and child [3] . In addition, the first limiting amino acid (LAA) when compared to an ideal protein composition is provided.

For comparison, previously determined animal-based DIAAS values for whey and pea were 107-109 and 62-82 respectively.

	Calculated IV DIAAS		
source	Child[3]	Adult[3]	LAA
BPC	91.1	97.2	Ile
CPC	25.3	30.0	Lys
LMC2	68.2	73.8	Leu
MP	33.6	39.5	SAA
NPP	49.3	57.8	SAA
TPP1	92.6	110.7	His/Leu
WPC	95.2	119.0	His
YPC	83.9	98.5	SAA

Conclusions

- The INFOGEST digestion protocol was complemented with a filtration step to simulate small intestinal uptake of amino acids in combination with an *in vitro* DIAAS calculation method
- The referent protein sources whey and pea show high correlation with previous determined animal-based DIAAS values Most of the alternative proteins have a good digestibility
- Whey, potato, blood plasma and yeast protein concentrates have a high *in vitro* DIAAS value
- Food products that result in too low recovery (like MP) with complex matrix and low protein content require further optimization of the method

References

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Wageningen University & Research
P.O. Box 123, 6700 AB Wageningen
Contact: Jurriaan.mes@wur.nl
M +31 (0)6 13801996
www.wur.nl/fbr

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