Nutrient composition and bioavailability of protein and energy in common fruits and vegetables prepared for human consumption


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Introduction

The nutritional value of a certain food is to a high degree depending on its composition and nutrient amount. The only true measurement of energy availability and protein quality for human use is growth and/or metabolic evaluation carried out in suitable subjects of the target population. Such studies cannot be done on a routine basis. However, an animal assay technique that correlate closely with data from human experiments is recommended by FAO/WHO. This method uses growing rats to measure the digestibility of energy and protein.

Aim

In the present study growing rats were used as animal model to evaluate the digestibility of energy and protein digestible corrected amino acid score (**PDCAAS**) in some common fruits and vegetable grown in different cultivation systems during two subsequent growth seasons.

Table 1. Amino acid requirement of pre -school children, and in comparison with growing rats and piglets (mg/g protein)

	Pre-school-child FAO, 1985	Growing rats NRC, 1995	Piglets, 9 -30 kg DS, 2002
Histidine	19	19	22
Isoleucine	28	41	38
Leucine	66	71	66
Lysine	58	61	65
Methionine+Cystine	25	65	35
Phenylalanine+Tyroxine	63	68	73
Threonine	34	41	40
Tryptophane	11	13	11
Valine	35	49	40

Principle of PDCAAS

- Measurement of the food protein (N x 6.25) and indispensable amino acids (see **Table 2**).
- Calculating the uncorrected amino acid score by dividing a particular indispensable amino acid by the corresponding amino acid with the requirement pattern for a 2-5 year child (see **Table 1**).
- Determine the protein digestibility corrected for metabolic faecal protein.
- PDCAAS is then calculated by applying the corrected protein digestibility (see **Table 3**).

Materials and Methods

- At two consecutive years, potatoes, peas, kale, carrots and apples were grown under either an organic, or a conventional cultivation system, or a combination of the two systems.
- Potatoes, peas and kale were cooked and freeze-dried; raw carrots and apples were shredded and freeze dried.
- Ingredients were incorporated into test diets by adjusting the nitrogen content to 1.5 % of DM with a N-free mixture; however, in case of low protein ingredients (potatoes, carrots and apple) casein was supplemented.
- Five Wistar rats weighing 70 g were used for each diet.
- An adaptation period of 5 d was followed by a balance period of 4 d.
- The rats were housed individually in plexiglas cages which allowed urine and faeces to be collected separately (see **Photos**).

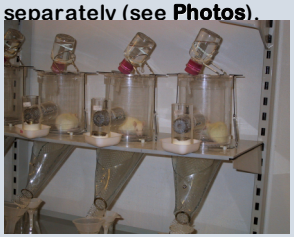

Table 2. Protein and indispensable amino acid composition of the experimental foods

	Apples	Carrots	Kale	Peas	Potatoes
Protein, % DM	1.7	7.1	18.6	25.6	8.8
Amino acids, mg/g protein					
Histidine	20	16	22	25	17
Isoleucine	36	32	43	44	34
Leucine	61	41	76	72	49
Lysine	55	33	58	74	49
Methionine+Cystine	28	21	31	23	27
Phenylalanine+Tyroxine	47	41	82	70	57
Threonine	37	29	44	41	34
Tryptophane [1]	9	9	16	11	15
Valine	46	41	57	52	54

[1]Table value (Levnedsmiddel tabeller, 1991).

Results and Discussion

- There was no significant difference between the different cultivation systems on the present variables.
- A significant difference was detected between the two growth seasons: On average there was a one percentage unit difference in protein between the two years giving rise to a significant improvement of amino acid concentration relative to protein, as the amino acid concentration was equal between the two years.
- In spite of the relative low protein content in apples (1.7 % of DM, **Table 2**), and a low protein digestibility (52 %, **Table 3**), the amino acid composition was well balanced.
- Both energy and protein digestibility correlated negatively to the content of dietary fibre (data not shown).
- Lysine turned out to be the limiting amino acid in both carrot and kale.
- The protein in peas and potatoes complemented each other; methionine+cystine limiting in peas and leucine and lysine limiting in potatoes.

Table 3. Energy and protein digestibility together with protein digestibility corrected amino acid score (PDCAAS)

	Apples	Carrots	Kale	Peas	Potatoes
Digestibility, %					
Energy	75	80	57	69	89
Protein, corrected	52	81	77	89	95
PDCAAS					
Histidine	56	66	90	115 ↔	84
Isoleucine	68	92	117	141	118
Leucine	49	50	88	97	71
Lysine	51	46	76	114 ↔	81
Methionine+Cystine	60	68	96	81 ↔	103
Phenylalanine+Tyroxine	39	52	100	99	87
Threonine	57	70	99	107 ↔	97
Tryptophane	42	66	111	89 ↔	130
Valine	69	95	124	131	147

Conclusion

Based on the rat model it could be concluded, that the PDCASS can be used to range the protein quality of the dietary ingredients giving rise to the following ranking: apples, carrots, potatoes, kale and peas.

The amino acid pattern in peas and potatoes complemented each other fairly well as dietary sources.

Years, but not cultivation system influenced the protein and amino acid content of the foods.