A simple laboratory method for estimating the standardised precaecal digestible crude protein and amino acids in feedstuffs for poultry

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BACKGROUND

Protein evaluation on the basis of precaecal digestible crude protein (pcdCP) and precaecal digestible amino acids (pcdAA) (Ravindran et al. 1999)

Problem
In vivo: invasive procedure (caecaectomisation, slaughtering)
In vitro: not standardised, time-consuming, enzymatic method
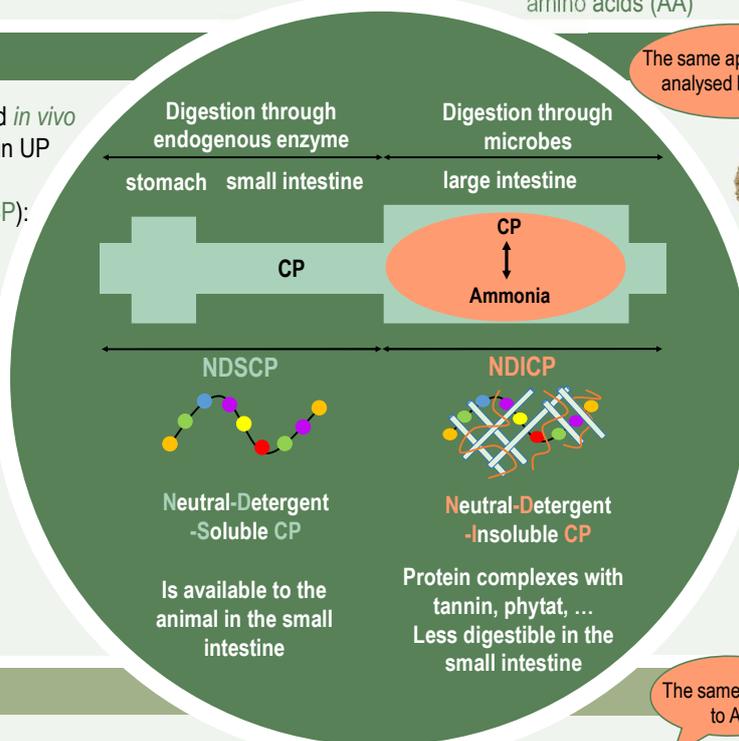(Boisen and Fernandez 1995)

OBJECTIVE
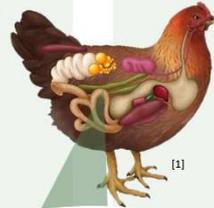
Adequate protein and amino acid supply for poultry [1]

✓ Ensuring performance and animal health
✓ Avoidance of excess nitrogen
✓ Precise evaluation: feed adapted to requirement
✓ Fast, standardised and well comparable laboratory method to estimate the precaecal digestible crude protein (CP) and amino acids (AA)
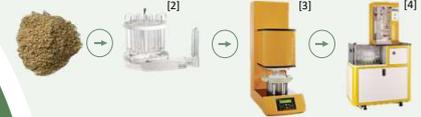
MATERIAL

- pcdCP & pcdAA already determined *in vivo*
- Single feed components of the Grain UP Project (Hohenheim, Germany)
- Broiler chickens: 34 samples (pcdCP): different cereal grains (rye, wheat, maize, barley, oats, spelt), different legumes and various components (buckwheat, maize grain silage)
- Laying hens: 67 of 80 samples analysed so far (pcdAA): different cereal grains (rye, wheat, triticale, maize, barley, oats, spelt), various
- Categorisation after N-containing compounds e.g. maillard products, tannin-protein-complexes
- Protein components: ADICP
- Cereal grains: NDICP

(Central diagram)

Digestion through endogenous enzyme
stomach   small intestine

Digestion through microbes
large intestine

CP

CP ↕ Ammonia

NDSCP
Neutral-**D**etergent-**S**oluble CP
Is available to the animal in the small intestine

NDICP
Neutral-**D**etergent-**I**nsoluble CP
Protein complexes with tannin, phytat, …
Less digestible in the small intestine

METHOD

The same applies to AA analysed by HPLC

1. NDICP or ADICP analysis [2] [3] [4]

2. NDSCP /ADSCP calculation

$$\text{NDSCP} = \text{CP}_{feed} - \text{NDICP}$$

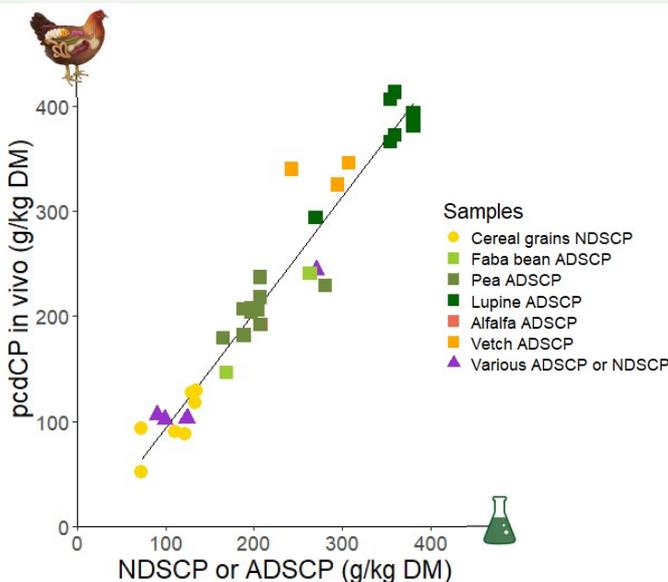**3. Creating a regression for pcdCP with *in vivo* and laboratory data**

4. Creating an estimation equation

$$y = a\,x + b$$

RESULTS

CRUDE PROTEIN

(Scatter plot: pcdCP in vivo (g/kg DM) vs NDSCP or ADSCP (g/kg DM))

Samples
- Cereal grains NDSCP
- Faba bean ADSCP
- Pea ADSCP
- Lupine ADSCP
- Alfalfa ADSCP
- Vetch ADSCP
- Various ADSCP or NDSCP

y = 1.105 (SE 0.051) x − 17.44 (SE 12.00), R² = 0.936, RMSE = 26.66

y = pcdCP reference *in vivo* (g/kg DM), x = NDSCP or ADSCP (g/kg DM)
R²= coefficient of determination, SE = Standard Error, RMSE = Root Mean Square Error

TOTAL AMINO ACIDS

y = 0.861 (SE 0.082) x + 1.879 (SE 8.510), R² = 0.625, RMSE = 11.61

y = pcdAA reference *in vivo* (g/kg DM), x = NDSAA (g/kg DM)
R²= coefficient of determination, SE = Standard Error, RMSE = Root Mean Square Error

CONCLUSION

The same applies to AA

- Determination of NDICP and ADICP standardised method (VDLUFA 2023) → easy establishment in laboratories
- Good and fast alternative to *in vitro*-method (Boisen and Fernandez 1995)
- Better and faster assessment of feedstuffs from new breeds or different processing methods
- Improving animal welfare (reduction of *in vivo*-trials) and animal health (reduction of ammonia emissions in the barn)
- Simple application using a formula for all feeds
- Transferability of the method from pigs (Schumacher et al. 2025) to poultry confirmed
- By using the species-specific estimation equation the analysed NDICP and ADICP content in a feed component can be used to estimate the pcdCP for pigs, poultry and horses

ACKNOWLEDGEMENT

LITERATURE

Boisen, S., Fernandez, J.A., 1995. Prediction of the apparent ileal digestibility of protein and amino acids in feedstuffs and feed mixtures for pigs by in vitro analyses. Anim. Feed Sci. Technol. 51, 29-43.

Ravindran, V., Hew, L.I., Ravindran, G., Bryden, W.L., 1999. A comparison of ileal digesta and excreta analysis for the determination of amino acid digestibility in food ingredients for poultry. British poultry science 40, 266–274. https://doi.org/10.1080/00071669987692.

Schumacher, V., Rodehutscord, M., Südekum, K.H., Kehraus, S., 2025. A simple laboratory method for estimating the standardised precaecal digestible crude protein in pig feeds. Livest. Sci. 293, March 2025, 105651. https://doi.org/10.1016/j.livsci.2025.105651.

VDLUFA-Verband Deutscher Landwirtschaftlicher Untersuchungs- und Forschungsanstalten, 2023. Methode 4.13.2, Rohproteinfraktionierung. In: Verband Deutscher Landwirtschaftlicher Untersuchungs- und Forschungsanstalten, Handbuch der Landwirtschaftlichen Versuchs- und Untersuchungsmethodik (VDLUFA-Methodenbuch). Bd. III Die chemische Untersuchung von Futtermitteln. VDLUFA-Verlag, Darmstadt, Germany.

[1] https://www.thehappychickencoop.com/chicken-anatomy/
[2] https://www.gerhardt.de/fileadmin/Redaktion/downloads/Produktdatenblaetter/Product_data_FIBRETHERM_german.pdf
[3] https://www.gerhardt.de/fileadmin/Redaktion/Freigestellte_Produktbilder/web_pic_fibretherm_450x450px_lu.jpg
[4] https://de.vwr.com/stibo/bigweb/std.lang.all/04/32/13410432.jpg