# Trends in feed evaluation for poultry with emphasis on in vitro techniques

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# ABSTRACT

Accurate knowledge of the actual nutritional value of individual feed ingredients and complete diets is critical for efficient and sustainable animal production. For this reason, feed evaluation has always been in the forefront of nutritional research. Feed evaluation for poultry involves several approaches that include chemical analysis, table values, prediction equations, near-infrared reflectance spectroscopy, in vivo data and in vitro digestion techniques. ….

**Keywords:** Poultry; Feed evaluation; In vivo assay; In vitrotechniques; Protein; Energy

# Introduction

Accurate ingredient evaluation is central to precise and cost-effective feed formulations. Ingredient variability is inherent and unavoidable. The primary aim of [feed evaluation](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/feed-evaluation) is to provide the [nutritionists](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/nutritionists) with reliable data on the digestible nutrient and [metabolizable energy](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/metabolizable-energy) contents of different ingredients, so that the expected variation between batches of ingredients could be incorporated into formulation matrices. …

## *2.1. Physical measurements*

### *Grain density and 1,000 kernel weight*

… Similarly, Wiseman (2000) reported that there were no significant correlations between bushel weight and 1,000-kernel weight versus the AME value of 50 wheat samples (from 10 varieties) fed to broiler chickens. … The digestion of most substrates is incomplete, with 10% to 20% being normally undigested and excreted ([Ravindran, 2013](https://www.sciencedirect.com/science/article/pii/S2405654521000019?dgcid=raven_sd_aip_email" \l "bib117)).

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## *2.3. Table values*

… For anyone perusing and comparing these databases, the inconsistency that exists among them will soon become clear. For example, AME values of 9.92, 9.71, 9.04, 9.80, 9.55 and 9.71 MJ/kg have been reported for soybean meal in NRC (1994), INRA (2002), CVB (2016), Evonik (2016), Rostagno (2017) and FEDNA (2017), respectively.

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This variation may be explained inter alia by differences in chemical composition, presence of the anti-nutritional factors (ANF), age and breed of birds and the experimental methodology ([Mateos et al., 2018](https://www.sciencedirect.com/science/article/pii/S2405654521000019?dgcid=raven_sd_aip_email" \l "bib93)).

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In brief, half a gram of ground sample is incubated with pepsin solution (containing 20-mg pepsin, 11,400 units) at 37 ◦C and pH 4.13 for 4 h in an agitating water bath. …

The residue and the original feed sample analyzed for gross energy and the in vitro digestible energy is calculated according to the following formula:

In vitrodigestible energy (kcal/g) = [(GE Feed × *F*) – (GE Residue × *R*)]/*F* ,

where GE Feed = gross energy of feed (kcal/g), *F* = weight of feed (g), GE Residue = gross energy of residue (kcal/g), and *R* = weight of residue (g).

…

## *3.2. In vitro prediction of protein digestibility*

…The second stage of digestion then proceeds for 4 h at 37 ◦C. At the end of the second stage of incubation, samples are centrifuged (1,250 × *g* for 10 min at a temperature of 5 ◦C) and supernatant discarded. The undigested precipitate is washed with distilled water, re-centrifuged and the supernatant again discarded. The residue is assumed to be the indigestible matter.

…

Clunies and Leeson (1984), testing 3 activities of pepsin (290, 580 and 1,140 units per 10 mL of 0.075 mol/L HCl) in the first stage of incubation, found that increasing pepsin activity from 290 to 580 units increased the in vitro DM and protein digestibility.

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1. **Conclusions and perspectives**

There is a continuing demand from the poultry feed industry to explore and develop rapid methods capable of assessing the nutritional quality of raw materials on a real-time basis. In this context, …

**Acknowledgement**

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**References**

Alvarenga RR, Rodrigues PB, Zangeronimo MG, Makiyama L, Oliveira EC, Freitas RTF, et al. Validation of prediction equations to estimate the energy values of feedstuffs for broilers: performance and carcass yield. Asian Australas J Anim Sci 2013;26:1474-1483.

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# Tables

Table 1. Estimating the energy value of feed and feed ingredients from chemical composition and digestibility values.

|  |  |  |
| --- | --- | --- |
| Ingredient | Prediction equation | Reference |
| Corn | MEn = 36.21 (CP) + 85.44 (EE) + 37.26 (NFE) | Janssen (1989)1 |
| … |  |  |
| Distillers dried grains  with solubles | TMEn = 2,732.7 + 36.4 (fat) - 76.3 (fiber) + 14.5 (protein) - 26.2 (ash) | Batal and Dale (2006)2 |
| … |  |  |

CF = crude fiber; CP = crude protein; EE = ether extract; …; TDF = total dietary fiber.

1MEn unit, kcal/kg DM; component unit, % (DM basis).

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Table 3. Reduced variation in apparent ileal digestibility coefficients of crude protein and essential amino acids (AA) of corn-soy diet for broilers determined in 5 research stations, using an agreed protocol1.

|  |  |  |  |
| --- | --- | --- | --- |
| Item | Range | CV, %  2 | *P*-value ≤ |
| Crude protein | 0.84 to 0.86 | 1.1 | 0.42 |
| … |  |  |  |

1 Ravindran et al. (2017).

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|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Table 5. The pH, relative length (%), relative capacity (%) and transit time (h) in different segments of the digestive tract of pigs. | | | | | |
| Segment | pH1 | Relative length1 | Relative capacity1 | Transit time (solid phase)2 | Transit time (liquid phase)2 |
| Stomach | 2.2 | - | 29.2 | 1.1 | 0.8 |
| Small intestine | 6.0 to 7.5 | 78 | 33.5 | 3.9 | 4.0 |
| … |  |  |  |  |  |

# Figures

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Fig. 1 xxx

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Fig. 2 xxx