Trakia Journal of Sciences, No 1, pp 31-35, 2022

Available online at:
http://www.uni-sz.bg

ISSN 1313-3551 (online) doi:10.15547/tjs.2022.01.004

Original Contribution

APPAREND AND TRUE METABOLIZABLE ENERGY OF HIGH PROTEIN SUNFLOWER MEAL IN BALANCE EXPERIMENTS WITH ROOSTERS

S. Chobanova[1], D. Penkov[2*]

[1]Section Animal Nutrition, Trakia University, Stara Zagora, Bulgaria
[2]Department of Animal Sciences, Agricultural University, Plovdiv

ABSTRACT
Aim: To establish the zero nitrogen corrected apparent (AMEn-o) and the true (TMEn-o) metabolizable energy of two batches high – protein (dehulled, with 45 and 50% crude protein in DM) sunflower meal.
Material and Methods: Standardized methods for balance experiments with poultry. The roosters were 1 year old – White Plymouth Rock – race. Six birds were tube fed and six feed deprived per each batch of fodder. Separately experiments with intact and caecoectomized roosters were conducted.
Results: The following levels (J/g DM) have been established: Batch 45%: (AMEn-o): intact: 8430, caecoectomized: 8317, mean: 8373; (TMEn-o): intact: 9221, caecoectomized: 9108, mean: 9164. For the batch 50% the results were: 9281, 10061, mean - 96711 and 9943, 10973, mean - 10458 J/g DM respectively.
Conclusion: The authors suggest that both feed batches can replace isoenergetic soybean meal in combined fodders for poultry.

Key words: Apparent metabolizable energy, true metabolizable energy, sunflower meal, roosters

INTRODUCTION

Energy is the first and most important parameter that should be considered while formulating total mix poultry rations, as it is necessary for metabolism, for physiological functions, life maintenance, growth, tissue metabolism and heat production. As early as the 1950s, the apparent metabolizable energy (AME), expressed as part of gross energy (GE) of the feed minus GE of excreta, was used in diet formulation (1).

Later, Sibbald (2) developed a method for the determination of the true metabolizable energy (TME), taking into account the endogenous energy losses with excreta. In order to provide a reliable database with energy content of poultry feed for nutrition specialists, a large dataset containing AME/TME values of all feed ingredients, fats and even additives e.g. enzymes, is necessary. The system for AME assay is widely used for the evaluation of feeds' and rations' energy content (1, 3, 4), yet it is not accurate for all circumstances (5, 6).

The literature provides data about the energy value of various feeds obtained by different assay methods: biological experiments with poultry (7) prediction equations (8) in vitro analyses with artificial digestive systems and near-infrared reflectance (NIR) analysis.

Despite the numerous research studies, no uniform system for accurate assessment of AME values of feed ingredients is available so far. Factors such as feed type, feed particle size, the temperature of feed processing, etc. have an impact to physicochemical characteristics of feed ingredients and hence, on their energy value (9, 10). What is more, the nutritional content,

***Correspondence to:** *Dimo Penkov, Department of Animal Sciences, Agricultural University – 4000 Plovdiv, dimopenkov@gmail.com*

including protein (12), fats (13, 14), crude fiber (15), variety, content of antinutritional factors (16), etc. could further influence feed energy value (15).

Data for metabolizable energy in different reference books often differ greatly, which is a concern. Some examples for discrepancy in AMEn content of sunflower meal with 34% crude protein content are data from Feedipedia (17) - 1.87 Mcal/kg and those from EDNA (18) - 1.52 Mcal/kg.

The aim of the present study was to establish the zero nitrogen corrected apparent (AMEn-o) and the true (TMEn-o) metabolizable energy of two batches high – protein (dehulled) sunflower meal in balanced experiments with intact and caecostomized (randomized) roosters.

MATERIAL AND METHODS

Balance experiments were carried out in the experimental base of the Animal Nutrition Unit, Faculty of Agriculture at the Trakia University – Stara Zagora, with two groups of White Plymouth Rock cockerels - intact and caecectomized (randomized). The original methods of Sibbald (2), modified by other authors (19, 20, 21) was used to this end. Two groups of birds were used in experiments – 6 tube fed and 6 feed deprived, after preliminary 48-hour feed deprivation and a true 48-hour experimental period. Fed birds received a single dose of about 50 g dry matter from feeds, directly placed into the crops. To maintain the body energy balance, birds received a determined amount of 10% glucose solution per os (21).

The energy of feed and excrements was determined using a microprocessor calorimeter KL11 Mikado, and nitrogen - by the method of Kjeldahl (22).

The original formulas of Sibbald (2) were used to calculate the apparent metabolizable energy (AME) and the true metabolizable energy (TME) adjusted to zero nitrogen balance (n-o):

AME = (EI-EO)/FI

AMEn-o = AME - 34.4xANR/FI

TME = AME + (FEL/FI)

TMEn-o = TME – [(34.4xANR/FI) – (34.4xFNL/FI)]

Where: AME – apparent metabolizable energy; EI – energy input with the fodder; EO – energy output from tube fed analogs; FI – fodder input; FEL – energy output from tube fed analogs; ANR – apparent nitrogen retained (nitrogen intake of tube fed – nitrogen output from tube fed); FNL – fasting nitrogen losses; n-o – corrected to O nitrogen balance.

The statistical processing was performed with the help of Microsoft - Excel - Descriptive statistics.

RESULTS AND DISCUSSION

The basic data for recalculation of the results for both of fodder batches are presented in **Table 1.**

Table 1. *Content of gross energy (MJ) and nitrogen (g) in 1 kg dry matter of the tested batches of sunflower meal*

Batches	45%	50%
Gross energy – MJ	18.725	18.720
Nitrogen-g	71.04	73.01

The gross energy of the two meals is similar due to the almost identical chemical composition of batches. Nitrogen content (crude protein respectively) was somewhat different. In batch 50 it was higher due to the fact that shells of seeds were completely dissolved and removed.

Compared to data available in the most recent Bulgarian references (23, 24) the nitrogen content of the two feed batches was higher, which is a prerequisite for the higher protein nutritional value of these novels for Bulgaria feeds. The differences could be attributed to the fact that modern sunflower varieties have a different chemical composition from those, used for production of meals in the cited references.

Table 2 reflects the main data from balance experiments, used as basis for metabolizable energy calculations. All experimental birds were intubated with sufficient amount of feed, compatible with that cited in the classical method (2), ensuring the correct performance of experimental and subsequent representability of data. The additional support with glucose guaranteed that birds felt no energy deficiency during the trial period and that their bodies (respectively digestive systems) have performed under optimum conditions.

Table 2. *Dry matter (g), gross energy (J) and nitrogen (g) input and energy (J) and nitrogen (g) output from tube fed and feed deprived analogs (n=6 tube fed and 6 feed deprived)*

Batches// Intact/caecectomized	DM input – g	GE input - J	N input - g	GE output – tube fed - J	N output - tube fed – g	Apparent N retained – g	GE output – feed deprived	N output – feed deprived - g
45% //intact	55.13±0.01	1032309±204	3.916±0.001	588302±11753	4.420±0.15	-0.51±0.34	88805±2220	1.51±0.48
45%// Caecoectomized	55.14±0.01	1032496±204	3.917±0.001	580784±11691	3.577±0.25	0.34±0.31	8911±1680	1.57±0.32
50% //intact	54.00±0.01	1010880±187	3.943±0.001	530460±12592	3.233±0.14	0.71±0.14	70685±2740	8.69±1.24
50%// Caecoectomized	53.99±0.01	1010693±187	3.942±0.001	451569±67330	3.802±0.55	0.14±0.03	89637±3108	8.52±2.14

Tube fed experimental analogs, both intact and caecotomized have received almost the same amounts of feed, respectively gross energy. For the sunflower meal batch 45, there was no differences in the energy released with excreta of intact and caecotomized analogs. In previous trials of ours (21) a similar relationship was determined also in Muscovy ducks. For sunflower meal batch 50, caecotomized analogs have released even less energy than intact birds, yet the differences were not statistically significant (P≥0.5).

Whereas the energy released with excreta of feed deprived intact and caecotomized birds was almost the same for batch 45, the intact birds have released by about 20000 J (20 kJ) less energy than caecotomized for batch 50. This had no effect on calculation of TME due to compensatory differences in nitrogen retentions as caecotomized birds demonstrated higher TMEn-o than intact one with respect to this batch **(Table 3).**

For batch 45, the amounts of nitrogen released from tube fed and feed deprived analogs, as well as from the tube fed birds for batch 50 were equal - from 3.2 to 4.4 g and 1.5 – 1.6 g and were compatible to values obtained in earlier trials of ours with other bird species (21), whereas feed deprived analogs from batch 50 released substantially more nitrogen: 8.5–8.7 g.

The calculation of metabolizable energy was characterized with the following more important relationships **(Table 3):**

Table 3. *Apparent and true zero N-balance corrected metabolizable energy, in the dry matter of the different lots of sunflower meal – J/g*

Fodders//rooster type	AME	**AME (n-o)**	TME	**TME (n-o)**
45%//intact	8113.80±10	**8429.81±60a***	9972.58±128	**9220.93±131a**
45% //caecoectomized	8133.14±15	**8316.93±10a***	9161.63±128	**9107.92±131a***
50% //intact	9014.17±10	**9280.74±12a***	10142.64±101	**9942.88±88a**
50%//caecoectomized	10338.07±38	**10060.87±33***	11266.75±103	**10973.02±87***

Notice: a-a – statistical significant by P≤0.5 between AMEn-o and TMEn-o within a batch
- - statistical significant by P≤0.5 under the batches

Comparison of batches showed that AMEn-o was statistically significantly higher (P≤0.5) in both intact and caecotomized birds. The difference for intact birds was by about 650 kJ, whereas in caecotomized – by about 2000 kJ/g DM.

The apparent metabolizable energy is a main parameter for evaluation of nutritional value of feeds in Europe and Bulgaria. The differences in AMEn-o between intact and caecotomized birds were irrelevant for batch 45, so data for this feed could be averaged to 8317 J/g DM.

The zero corrected true metabolizable energy of batch 45 was statistically significantly higher (P≤0.5) compared to AMEn-o of both intact and caecotomized birds. The difference between intact and caecotomized analogs were insignificant, so the average value was 9164 J/g DM (by about 800 J/g more).

In general, batch 50 had considerably (P≤0.5) higher metabolizable energy than batch 45 in both intact and caecotomized birds. A statistically significant difference was found out when AMEn-o and TMEn-o of intact birds were compared: 9281 vs 10061 J/g DM (P≤0.5), whereas this difference was inconsistent for caecotomized analogs (9943 vs 10973 J/g DM). To sum up, regarding sunflower meal batch 50, averaged values for intact and caecotomized birds were 9671 J/g DM for AMEn-o and– 10458 J/g DM for TMEn-o.

When compare the established from us results with these cited from (23, 24) and Europe (8) for AMEn-o and (2, 25, 26) for TMEn-o, it can be argued that in terms of energy nutrition, the tested batches of feed are higher than those for ordinary sunflower meal and are compatible with the energy values of soybean meal.

CONCLUSIONS

The following levels of metabolizable energy of sunflower meal (kJ/g DM) have been established:

1. With 45% crude protein:

- Apparent metabolizable energy corrected to O nitrogen balance (AMEn-o): intact: 8430, caecoectomized: 8317, mean: 8373.
- True metabolizable energy corrected to O nitrogen balance (TMEn-o): intact: 9221, caecoectomized: 9108, mean: 9164.

2. With 50% crude protein:

- AMEn-o: intact: 9281, caecoectomized: 10061, mean: 9671.
- TMEn-o: intact: 9943, caecoectomized: 10973, mean: 10458.

The results obtained indicate that both feed batches can replace isoenergetic the soybean meal in combined fodders for poultry.

REFERENCES

1. Hill, F. W. and D. L. Anderson, Comparison of metabolizable energy and productive energy determinations with growing chicks. *Journal of Nutrition*, 64:587–603.3, 1958.
2. Sibbald, I.R., *The TME System of Feed Evaluation: Methodology, Feed Consumption, and Bibliography*, Tech. Bull. 1986-4E, Ottava Canada: Agriculture Canada, 1986.
3. Vohra, P., Evaluation of metabolizable energyfor poultry. *Worlds Poult. Sci. J.* 28:204–214,4, 1972.
4. Bourdillon, A., B. Carr'e, L. Conan, J. Duperray, G.Huyghebaert, B. Leclcercq, M. Lessire, J. McNab and J.Wiseman. European reference method for thein vivodetermination of metabolisable energy with adult cockerels:Reproducibility, effect of food intake and comparison withindividual laboratory methods. *British Poult. Sci.* 31:557–565,1990.
5. van der Klis, J. D. and J. Fledderus, Evaluation of raw materials for poultry: what's up? Pages 123–130, in *Proc. 16th Eur. Symp. Poult. Nutr. (ESPN)*. Strasbourg, France, 6, 2007.
6. Choct, M., Feed energy- what system to use andprospects for evaluation. Pages 1–8 in *XXIV World's Poult.Congress. Salvador de Bahia, Brazil*, 2012.
7. Yegani, M. and D. R. Korver, Review: Prediction of variation in energetic value of wheat for poultry. *Canadian J.of Animal Sci.* 92:261–273, 2012.
8. Jenssen, W. M., *European Table of Energy Values for Poultry Feedstuffs*, 3-rd Ed., Beekbergen, Netherlands: Spelderholt Center for Poultry Res. And Information Services, 1989.
9. McKinney, L.J.and R.G. Teeter, Predicting effective caloric value of nonnutritive factors: I. Pellet quality and II. Prediction of consequential formulation dead zones. *Poultry Sci.*, 83, 1165-1174, 2004.
10. Skinner-Noble, D.O., L.J. McKinney and R.G.Teeter, Predicting effective caloric value of nonnu-tritive factors: III. Feed form affects broiler performance bymodifying behavior patterns. *Poultry Sci.* 84:403–411, 2005.
11. Jim ́enez-Moreno, E., A. De Coca-Sinova, J. M.Gonz ́alez-Alvarado and G. G. Mateos, Inclusion ofinsoluble fiber sources in mash or pellet diets for youngbroilers. 1. Effects on growth performance and water intake. *Poultry Sci.*, 95, pp. 41-52, 2016.
12. Lopez, G. and S. Leeson, Assessment of thenitrogen correction factor in evaluating metabolizable energyof corn and soybean

meal in diets for broilers. *Poultry Sci.*87:298–306, 2008.

13. Mateos, G. G.and J. L. Sell, True and apparentmetabolizable energy value of fat for laying hens: influenceof level of use. *Poultry Sci.* 59:369–373, 1980.
14. Mateos, G. G., and J. L. Sell, Influence of car-bohydrate and supplemental fat source on the metabolizableenergy of the diet. *Poultry Sci*. 59:2129–2135, 1980a.
15. Ravindran, V., Y. B. Wu, D. G. Thomas and P.C.H.Morel, Influence of whole wheat feeding on the devel-opment of gastrointestinal tract and performance of broilerchickens. *Australian J.of Agric. Research*, 57:21–26.37, 2006.
16. García-Rebollar, P., L. Cámara, R. P. Lázaro, C.Dapoza, R. Perez Maldonado and G. G Mateos, Influence of the origin of the beans on the chemical compositionand nutritive value of commercial soybean meals. *Animal Feed Sci. and Technol*ogy, 221:245–261, 2016.
17. Feedipedia, Animal Feed Resources Information System. Accessed April 2017, http://www.feedipedia.org/.
18. EDNA (Fundación Española para el Desarrollo dela Nutrición Animal), *Revisión de las Normas FEDNAde Composición y Valor Nutritivo de Alimentos para la Fabricación de Piensos Compuestos*. 4th ed. FEDNA,Madrid, Spain, 2017.
19. Ragland, D., Thomas, C.R., Elkin, R.G., Shafer, D.J. and Adeola. O., The influence of caecectomy on metabolizable energy and amino acid digestibility of selected feedstuffs for White Peking ducks, *Poultry Sci.*, 78, 707-713, 1999.
20. Ravindran, V., Standardizing ileal amino acid digestibility of raw material – approach in broiler feed formulations, *Proceedings of WPC*, 8-13.06, Istanbul, Turkey, 2004.
21. Penkov, D., *Establishing of the metabolizable energy and the true digestibility of the amino acids of some fodders by experiments with Muscovy ducks C. moshata*, Dissertation (DrSci) pp 314, (Bg), 2008.
22. AOAC international, *Official methods of analysis of AOAC (*18 edition, rev. 2), Association of Official Analytical Chemists Intern, Gaithersburg, MD, USA, 2007.
23. Todorov, N., Marinov, B., Ilchev, A., Penkov, D., Georgieva, V., Ganchev, G. and Chobanova, S., *Applied feeding of productive animals*, IFO-Design, Sofia, ISBN 9789542944126, (Bg), 2016.
24. Todorov N., D. Girginov, Z. Shindarska, A. Ilchev and D. Penkov, *Animal Nutrition*, ISBN 9789543053100, pp. 345 (Bg), 2017.
25. NRC, *Nutrient requirements of poultry*, 9-th rew. ed. NAP, Washington DC, Agriculture, 1994.
26. Summers, J. and S. Lesson, *Commercial Poultry Nutrition*, Julep, Ontario, Canada, pp 140, 1996.