AGRICULTURAL SCIENCE AND TECHNOLOGY, VOL. 13, No 4, pp 378-381, 2021
Published by Faculty of Agriculture, Trakia University, Bulgaria
ISSN 1313-8820 (print)
ISSN 1314-412X (online)
http://www.agriscitech.eu
DOI: 10.15547/ast.2021.04.061

True digestibility of the essential amino acids of high-protein sunflower meals by balanced experiments with intact and caecectomized birds from *Gallus* species

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

[1]Department of Morphology, Physiology and Nutrition, Section Animal Nutrition, Faculty of Agriculture, Trakia University, 6000 Stara Zagora, Bulgaria
[2]Department of Animal Sciences, Faculty of Agronomy, Agricultural University, 12 D. Mendeleev Str., 4000 Plovdiv, Bulgaria

(Manuscript received 2 September 2021; accepted for publication 10 November 2021)

Abstract. *Using adapted methods for balanced experiments with poultry, the true digestibility coefficients of the essential amino acids of two high protein sunflower meals – 40+® and 47® have been established. The true digestibility coefficients by using two methods – with intact and randomized (caecectomized) birds have been compared. Six birds were tube fed and six – feed deprived for both of the fodders. The amino acids were established with amino analyzer AAA-881 after preliminary HCl hydrolysis. The mean digestibility of sunflower meal 40+® is higher in intact (88.11 versus 85.73 of sunflower meal 47®) compared to randomized birds (87.20 versus 85.46 of sunflower meal 47®). The differences by lots are statistically significant only in intact birds. The authors recommend for practical needs to use the average true digestibility coefficients between both meals, established with randomized birds (ileal digestibility).*

Keywords: amino acids, high-protein sunflower meal, poultry, true digestibility

Introduction

True digestibility of amino acids of feeds is the most accurate method for determination of protein value of poultry feeds (Carpenter, 1973; Todorov et al., 1995; D'Mello, 2000). Despite the differences between digestibility and availability, at present (Fuller, 2003) determination of digestibility is the globally standardized method (Sibbald, 1986; Surdjiyska, 1990; Ravindran, 2004; Penkov, 2008).

Yet, the teaching and scientific Bulgarian literature still uses data about digestible amino acids for poultry, published by Sibbald (1986), NRC (1994), Degussa (2005) and Todorov et al. (2016).

One of the most commonly used protein sources in pig and poultry nutrition is sunflower meal (SM) - Kabakchiev et al. (2014); Surdjiyska et al. (2015). Georgieva et al. (2007, 2008a,b) have investigated the effect of dietary enzymatic supplements in broiler chickens fed higher levels of sunflower meal 37 and demonstrated that the increased crude fibre level was not a limiting factor of productive performance. Chobanova (2019) has investigated the effect of various levels of high-protein sunflower meal on productivity of broiler chickens and found out a negative impact on growth performance and increased feed conversion ratio.

Data for SM nutritional value are available only for SM with flakes (SM 25) and partially dehulled one (SM 37) – Todorov et al. (2007, 2016). The interest of numerous researchers is focused on the possibilities for replacement of soybean meal with sunflower meal (Raiesh et al., 2006; Brenes et al., 2008; Salari et al., 2009; Araújo et al., 2011).

During the last 10-15 years, Bulgaria produces high-protein SM batches, successfully used for feeding small pigs and poultry. The substitution of soybean meal with SM containing more than 40% crude protein (SM 40+®) and even 47% crude protein on dry matter basis (SM 47®) are not only subject of research, but also scientific data for successful replacement of both meals to obtain comparable productive traits in pigs and poultry.

The aim of the present investigation was to provide the newest objective data for the true digestibility of essential amino acids of two high-protein sunflower meals – SM 40+® and SM 47®, in experiments with gallinaceous birds.

Material and methods

Balance experiments were carried out in the experimental base of Animal Nutrition unit, Faculty of Agriculture, Trakia University – Stara Zagora, with two groups of White Plymouth Rock cockerels - intact and caecectomized (randomized). The method of Sibbald (1986), modified successively by Ragland et al. (1999), Ravindran (2004) and Penkov (2008) was used to this end. Two groups of birds were used in both experiments – 6 tube fed and 6 feed deprived, after preliminary 48-hour feed deprivation and a true 48-hour experimental period. Fed birds

*e-mail: dimopenkov@gmail.com

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* according to Penkov (2008).

The amino acid content in feed and excrements was determined on AAA-881 amino analyzer after preliminary HCl hydrolysis. Despite that hydrolysis destroyed some of the sulfur-containing amino acids, we assumed that a similar destruction was present both in feed and excrements, so that true digestibility coefficients in the present study could be considered consistent.

The true digestibility of amino acids was determined by the formula of Sibbald (1986) and Surdjiyska (1990):

True digestibility coefficient = [Feed content - (faecal content of tube fed - faecal content of feed deprived)]/Feed content *100

The results are statistically processed through panel "descriptive statistics" - Microsoft Excel.

Results and discussion

The content of essential amino acids in both feeds is shown in Table 1. The highest content was that of arginine in both feed batches – 6.358 g in SM 40+® and 7.918 g/100 g protein in SM 47®, whereas the lowest – that of isoleucine in SM 40+® -1.909 g, and that of tyrosine in SM 47® -2.325 g/100 g protein.

Table 1. Content of essential amino acids in the tested sunflower meals, g

Amino acid	Batch of sunflower meal			
	40+®		47®	
	In 1 kg dry matter	In 100 g protein	In 1 kg dry matter	In 100 g protein
Lysine	1.073	2.346	1.168	2.560
Methionine+cystine	1.026	2.243	1.042	2.284
Arginine	2.908	6.358	3.613	7.918
Histidine	1.614	3.529	1.508	3.305
Phenylalanin	1.787	3.907	3.009	6.594
Thyrosine	0.908	1.985	1.061	2.325
Leucine	2.611	5.708	3.341	7.322
Isoleycine	0.873	1.909	1.380	3.024
Valine	1.253	2.739	1.679	3.68
Treonine	1.498	3.275	2.067	4.53
Content of crude protein	45.18	-	46.11	-

Sunflower meal is rich in sulfur-containing amino acids, but their content in the present experiments was relatively low due to the sample hydrolysis method. We recommend extrapolation of data for crude sulfur-containing amino acids in SM 37 reported by Summers and Lesson (1996) and Degussa (2005) vs 45% crude protein and recalculation as digestible against the true digestibility coefficients presented in Table 2.

In available literature, we found no data about available essential amino acids levels in high-protein sunflower meals (with over 40% crude protein content).

Table 2. True digestibility coefficients of the essential amino acids of the different batches of sunflower meal by experiments with *Gallus* species

Amino acid	Batch of sunflower meal			
	40+®		47®	
	Inact birds, x±Sx	Caecoectomized birds, x±Sx	Intact birds, x±Sx	Caecoectomized birds, x±Sx
Lysine	86.75±0.59[a]	87.79 ±0.50	83.66 ±0.01[a]	86.38 ±1.66
Methionine+Cystine	89.44±1.24	90.01±0.87	88.99±1.11	91.13±0.48
Treonine	84.05 ±0.70*	81.59 ±0.53*	84.54 ±0.02	79.46 ±2.94
Isoleycine	89.15 ±0.46[a]	89.23 ±0.42[b]	84.59 ±0.02[a]	84.03 ±2.23[b]
Leucine	85.61 ±0.59[a]	85.32 ±0.54[b]	80.24 ±0.03[a]	81.15 ±2.60[b]
Valine	86.81 ±0.57	86.85 ±0.51	85.16 ±0.02	86.29 ±2.26
Arginine	96.44 ±0.10[a]*	95.99 ±0.15[b]*	93.69 ±0.005[a]	93.03 ±1.00[b]
Histidine	86.89 ±0.32[a]*	82.61 ±1.04*	82.61 ±0.60	82.73 ±1.16
Phenylalanine	88.34 ±0.28[a]	87.78 ±0.46[b]	85.38 ±0.02[a]	84.09 ±2.45[b]
Thyrosine	87.40 ±0.59*	85.16 ±0.61*	88.40 ±0.02	86.19 ±2.13
Average true digestibility of the essential amino acids	88.11±0.59[a]	87.20±0.47	85.73±0.09[a]	85.46±2.14
True digestibility of the protein (nitrogen)	87.98±1.12	87.75±1.22	86.18±1.42	87.01±1.84

Note: *-* - The differences within 1 meal are significant by p≤0.5; a-a – the differences under intact birds between both fodders are statistically significant by p≤0.5; b-b - the differences under randomized birds between both fodders are statistically significant by p≤0.5.

The average true digestibility of amino acids in SM 40+ was by about 2% higher than that of SM 47®, with statistically significant differences in intact birds (p≤0.05). The highest digestibility in SM 40+® was demonstrated by arginine - 96.44 (intact) and 95.99 (caecectomized), and the lowest one: by threonine –84.05 (intact) and 81.59 (caecectomized birds). Higher digestibility of intact birds vs randomized was found out for threonine (+2.5%), arginine (+0.5%), histamine (+4%) and tyrosine (+2%), with statistically significant differences (p≤0.05). Higher yet inconsistent digestibility was observed for lysine and methionine+cysteine.

For SM 47®, the test method showed no statistically significant differences for both average digestibility of amino acids and individual values. The highest digestibility was detected for arginine – 93.69 (intact birds) and 93.03 (caecectomized birds), whereas the lowest: for histidine - 82.61 (intact) and treonine - 79.46 (caecectomized birds).

Unlike meals with higher crude fibre content, which has a considerable influence on amino acid digestibility, the differences between both sunflower meals were smaller. According to standardized method and due to the fact that differences in digestibility are relatively small (despite the presence of consistent differences for some amino acids), we believe that for practical purposes, averaged true digestibility coefficients between both meals in experiments with caecectomized (randomized) birds could be employed.

Compared to data for the true digestibility of proteins (nitrogen) of both meals, the differences with averaged digestibility values of essential amino acids were not high, which points indirectly to the circumstance that experiments were carried out without omissions and that the equipment was accurately tuned.

The true digestibility coefficients established by us for both meals showed certain differences vs official data used in Bulgaria (Todorov et al., 2007, 2016). For example, on the basis of the cited reference, true digestibility of lysine was -14 units for SM 45 and -12.5 units for SM 47®. The differences for threonine are -12.5 and -20 units, respectively, and for methionine and cysteine: -9 and -6 units. Similar differences were found out also from comparisons with official international references – Yamazaki and Kamata (1986), Green et al. (1987), NRC (1994), Degussa (2005), etc.

These differences are mainly a consequence of changed nutritional value of new sunflower varieties and hybrids, accompanied with new methods of dehulling as well as of new poultry selection achievements. It is therefore necessary to update the database for protein nutritional value of poultry feeds at 5-year intervals at least.

Table 3 presents calculated true digestible amino acids on dry matter basis of both meals, suitable for practical use.

Table 3. Content of true ileal digestible essential amino acids in sunflower meals 40+® and 47® – g/kg dry matter (mean data)

True ileal digestible essential amino acid	g/kg DM high protein sunflower meal*
Lysine	0.98
Methionine+Cystine	0.94**
Treonine	2.63
Isoleycine	1.35
Leucine	2.00
Valine	0.85
Arginine	2.81
Histidine	0.93
Phenylalanine	1.26
Thyrosine	1.26

*Note: The calculation of the content in native feed (90% dry matter) is done by multiplying the values shown in the table by a coefficient of 0.9;
**Hydrochloric acid hydrolysis destroys up to 30% of sulfur-containing amino acids.

Conclusion

It was found: 1) The average true digestibility of essential amino acids of sunflower meal 40+® in experiments with intact birds was 88.11, and with randomized (ileal digestibility) - 87.20. The highest digestibility was detected for arginine – 96.44 (in intact) and 95.99 (in caecectomized birds) whereas the lowest one: for threonine – 84.05 (in intact) and 81.59 (in caecectomized birds). 2) The average true digestibility of essential amino acids of sunflower meal 47® in experiments with intact birds was 85.73, and with randomized (ileal digestibility) – 85.46. The highest digestibility was found out for arginine 93.69 and 93.03, respectively, and the lowest one: for phenylalanine (intact) 83.77 and for threonine - 79.46 (randomized birds). 3) In practical settings, it is recommended to use averaged true digestibility coefficients of both meals established in randomized birds (e.g. ileal digestibility).

References

Araújo LF, Araújo C, Petroli N, Laurentiz A, Albuquerque R and Neto M, 2011. Sunflower meal for broilers of 22 to 42 days of age. Revista Brasileira de Zootecnia, 40, 142-2146. doi: 10.1590/S1516- 35982011001000011.

Brenes A, Centeno C, Viveros A and Arija I, 2008. Effect of enzyme addition on the nutritive value of high oleic acid sunflower seeds in chicken diets. Poultry Science, 87, 2300-2310. doi: 10.3382/ps.2008-00130.

Carpenter KJ, 1973. The estimation of the available sulfur amino acids in animal protein food. Biochemistry Journal, 90, 604-610.

Chobanova S, 2019. Effects of compound poultry feed

with different content of high-protein sunflower meal on growth performance of broiler chickens. Bulgarian Journal of Agricultural Science, 25, 91-94.
D'Mello J, 2000. Farm Animal Metabolism and Nutrition, CAB int. UK, p. 320.
Degussa, 2005. Standardized Ileal amino acid digestibility in broilers. November 2005, Degussa AG Company. https://www.efeedlink.com/contents/11-21-2005/032ac11a-2df1-4967-955e-455cccbea8e1-a001. html
Fuller M, 2003. Amon acid bioavailability – a brief history. In: Proceeding of the 9th International Symposium - Digestive physiology in pigs (ed. R.O. Ball), 1, pp. 183-198.
Georgieva V, Chobanova S, Ganchev G and Manolov I, 2007. Investigation on the effect of supplementing compound poultry feed with high sunflower meal levels with the enzyme preparation Xybeten. Journal of Mountain Agriculture on the Balkans, 10, 411-424 (Bg).
Georgieva V, Ganchev G, Chobanova S, Manolov I, Girginov D and Dincov D, 2008a. Effect of supplementing compound poultry feed with different sunflower meal level with enzyme preparation Xybeten on productive characteristics. Bulgarian Journal of Animal Husbandry, XLV, 4, 159-164 (Bg).
Georgieva V, Chobanova S, Ganchev G, Manolov I and Girginov D, 2008b. Study on the effect of supplementation with enzyme preparation Roxazyme G2 in compound feeds for broiler chickens with different sunflower meal content on productive characteristics. Bulgarian Journal of Animal Husbandry, XLV, 4, 153-158 (Bg).
Green S, Bertrand S, Duron M and Millard R, 1987. Digestibilities of amino acids in soybean, sunflower and groundnut meal detected with intact and caecectomized cockerels. British Poultry Science, 28, 643-652.
Kabakchiev M, Alexieva D, Genchev A, Nikolova M and Gerzilov V, 2014. Poultry Breeding, ISBN 9789545172076, p. 488 (Bg).
Nutrient requirements of poultry (NRC), 1994. Ninth Revised Edition. In: Nutrient Requirements of Domestic Animals, National Research Council, National Academy Press, Washington D.C. doi: https://doi.org/10.17226/2114
Penkov D, 2008. Establishing of the metabolizable energy and the true digestibility of the amino acids of some fodders by experiments with Muscovy ducks *C. moshata*. Thesis for DSc, Agricultural University of Plovdiv (Bg).
Ragland D, Thomas CR, Elkin RG, Shafer DJ and Adeola O, 1999. The influence of caecectomy on metabolizable energy and amino acid digestibility of selected feedstuffs for White Peking ducks. Poultry Science, 78, 707-713.
Rajesh MM, Sudhakara P and Reddy PVVSN, 2006. Effect of sunflower meal with or without enzyme supplementation on the performance of broilers. Indian Journal of Veterinary and Animal Sciences, 2, 200-204.
Ravindran V, 2004. Standardising ileal amino acid digestibility of raw material – approach in broiler feed formulations. In: Proceedings of WPC, 8-13.06.2004, Istanbul, Turkey.
Salari S, Nassiri Moghaddam H, Arshami J and Golian A, 2009. Nutritional evaluation of full-fat sunflower seed for broiler chickens. Asian-Australian Journal of Animal Sciences, 22, 557-564.
Sibbald IR, 1986. The TME System of Feed Evaluation: Methodology, Feed Consumption, and Bibliography. Tech. Bull. 1986-4E, Ottava Canada: Agriculture Canada.
Summers D and Lesson S, 1996. Commercial Poultry Nutrition, Third Edition, University Books Guelph, Ontario, Canada, p. 140.
Surdjiyska S, 1990. Digestibility of the protein and the amino acids in basic compounds for producing of combined fodders for broilers. Thesis for DSc, Agricultural Academy, Sofia, p. 342 (Bg).
Surdjiyska S, Angelova L, Tzenkov Tz and Grigorova S, 2015. New high protein sunflower product "Sunpro". Ptizevadstvo (Bulgarian Poultry Farming), 3, 13-18 (Bg).
Todorov N, Marinov B and Alexiev A, 1995. Basic animal nutrition. Agroprogress Publ. house, ISBN 9544670122 (Bg).
Todorov N, Krachunov I, Djuvinov D and Alexandrov A, 2007. Reference book of animal nutrition. Matcom Publ. house, Sofia, ISBN 9789549930474 (Bg).
Todorov N, Marinov B, Ilchev A, Penkov D, Georgieva V, Ganchev G and Chobanova S, 2016. Applied feeding of productive animals. IFO-Design, Sofia, ISBN 9789542944126 (Bg).
Yamazaki M and Kamata H, 1986. Amino acid availability of feed ingredients for poultry. Japanese Poultry Science, 23, 147-156.