Ann. Zootech., 1986, **35** (1), 79-86

A comparative study of the digestibility of soyabean and cottonseed meal amino acids in domestic chicks and muscovy ducklings

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Summary

True digestibilities of amino acids derived from soyabean and cottonseed meal were measured in domestic chicks and muscovy ducklings. Endogenous amino acid losses were determined in animals fed on a protein-free diet. Similar endogenous losses were found in both species. Slight, but significantly different protein digestibilities, were observed with a basal diet. The digestibility of lysine and arginine derived from soyabean meal was slightly greater in ducklings. The digestibility of cottonseed meal leucine was slightly higher in chicks than in ducklings. These results suggest that, for practical purposes, digestibility values from the chicken are adequate for the formulation of duckling diets.

Key words : amino acids, digestibility, chicken, duck.

I. Introduction

Duck diets are usually formulated on the basis of metabolisable energy (ME) values obtained from the domestic chicken, and crude protein and amino acids content. In a previous study (MOHAMED *et al.*, 1984), we have shown that the ME values of various feedstuffs are similar in chicks and in ducklings, but that the apparent digestibility of protein appears to be slightly higher in ducklings. Therefore in this study true digestibilities of protein and individual amino acids were measured in samples of protein meals derived from soyabean and cottonseed.

II. Material and methods

Samples of feeds and digesta coming from the experiment 3 described in a previous study (MOHAMED *et al.*, 1984) were analysed for protein and amino acids. Only basal diet, soyabean diet and cottonseed diet were kept for the present study.

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Experimental conditions have been described previously (MOHAMED *et al.*, 1984). There were six 8 week-old chickens or ducklings per diet. Each diet was given by force feeding with a syringe after melting with water (55-45 ; W/W). A complementary experiment was undertaken in order to determine the endogenous excretion of amino acids. A protein free diet, whose composition is presented in table 1, was given by force feeding birds three times per day. Protein free diet was mixed with water (66.6-33.3 ; W/W). Daily amounts of food ingested were ajusted in order to cover the energy requirements of birds (about 105 g/d). Feeding with protein free diet lasted 3 days. Excreta were collected during the last 2 days.

TABLE 1

Composition of experimental diets.
Composition des régimes expérimentaux.
(g . kg^{-1})

	Basal diet *Régime de base*	Protein-free diet *Régime sans protéines* ***
Maize - *Maïs*	860	
Soyabean meal - *Tourteau de soja*	100	
Maize starch - *Amidon de maïs*		607
Sucrose		200
Maize oil		50
Tallow		50
Cellulose		40
Glucose		50
Calcium carbonate	20	
Dicalcium phosphate	10	
Vitamin mixture *	5	
Mineral mixture **	5	
Salt		3

* Amounts supplied (mg/kg diet) = retinol, 0.003 ; cholecalciferol, 0.038 ; tocopherol acetate (250 g . kg^{-1}), 60 ; riboflavin, 4 ; calcium pantothenate, 8 ; menadione, 5 ; niacine, 25 ; pyridoxine, 1 ; cyanocobalamine (0.1 g . kg^{-1}), 80 ; folic acid, 0.2 ; biotin, 0.1 ; choline chloride, 500.

** Amounts supplied (g/kg diet) : MnO_2, 0.07 ; ZnO, 0.05 ; $FeSO_4$, 7 H_2O, 0.07 ; $CuSO_4$ 5 H_2O, 0.005 ; $CoCO_3$, 0.0003 ; KI, 0.00105 ; NaCl, 4.

*** Protein content (N × 6.25) was 2.5 mg . kg^{-1}.

Aliquots of the excreta were hydrolysed with 6N HCl for 24 h at 110 °C and their amino acids content measured using an Autoanalyser (LKB 4400 Amino Acid Analyzer). Duplicate measurements were made for each sample. The nitrogen content of the excreta was determined by the Kjeldahl procedure. Endogenous fecal and urinary nitrogen was determined by the method described by TERPSTRA *et al.* (1974). The diets were analyzed for crude protein and amino acids ; results are given in table 2.

TABLE 2

Amino acids composition of experimental diets.
Composition en acides aminés des régimes expérimentaux.
($g \cdot kg^{-1}$)

	Basal diet	Soyabean diet	Cotton diet
Aspartic acid	7.1	28.3	22.4
Threonine	4.3	14.6	11.1
Serine	4.5	15.2	11.9
Glutamic acid	15.9	47.7	44.1
Glycine	3.1	10.8	11.5
Alanine	5.4	13.6	11.6
Valine	4.4	12.9	11.2
Isoleucine	3.3	12.3	5.6
Leucine	9.0	23.5	17.3
Tyrosine	3.2	11.1	8.4
Phenylalanine	4.5	15.3	13.8
Lysine	4.1	15.7	11.8
Histidine	2.4	7.3	7.4
Arginine	5.2	18.1	26.5
Crude protein	121.6	295.2	275.2

True digestibilites of amino acids of pure feedstuffs were calculated according to the following equation :

$$TD\ (p.\ 100) = 100 \times \frac{(IAAd - 0.5\ IAAb) - (EAAd - EAAe - 0.5\ EAAb)}{(IAAd - 0.5\ IAAb)}$$

where :

IAAd = the amount of amino acid ingested in the experiment diet.
EAAd = the amount of amino acid excreted with the experiment diet.
EAAe = the amount of amino acid of endogenous origin excreted.
IAAb = the ingested amount of amino acid from basal diet.
EAAb = the excreted amount of amino acid coming from basal diet.

Endogenous losses were supposed to be independant from ingested diet and digestibilities were supposed to be additive.

Statistical analysis was made by analysis of variance.

III. Results

The daily rate of excretion of endogenous individual amino acids is shown in table 3. Similar amounts of each amino acid were lost by chicks and ducklings. As the birds had similar body weights, endogenous losses did not appear to differ greatly between these species. However the values observed in the present

study are about twice those given by other authors working with fed adult cockerels (MUTZAR & SLINGER, 1980 ; PARSONS *et al.*, 1983). These differences may be due either to the age of birds or to the very small amount of Kjeldahl nitrogen measured in the protein free diet. Indeed endogenous losses of amino acids have only been determined in adults and, to our knowledge, no comparison between adult and young birds are available. As for the effect of protein coming from the protein free diet, it may be estimated as about 262 mg (105 g × 2.5 g . kg^{-1}) which is not enough to explain the higher losses observed in this experiment.

TABLE 3

Endogenous amino acids losses (mg/bird/day).

Pertes endogènes d'acides aminés (mg/animal/jour).

	Chicken* *Poulet*		Duckling* *Caneton*	
Excreta (g dry matter)	20.02	(16.7)**	14.4	(7.00)
Endogenous fecal land urinary N (g)	1.58	(0.244)	1.93	(0.300)
Aspartic acid	83.6	(17.9)	89.5	(12.8)
Threonine	71.9	(13.1)	90.0	(21.4)
Serine	74.4	(10.8)	85.8	(18.9)
Glutamic acid	149.6	(20.9)	154.9	(40.6)
Glycine	84.4	(11.4)	84.6	(32.4)
Alanine	62.9	(11.8)	81.0	(38.8)
Valine	80.7	(15.1)	98.2	(32.8)
Isoleucine	50.9	(8.6)	58.8	(18.4)
Leucine	85.3	(11.0)	93.1	(24.4)
Tyrosine	42.4	(3.7)	54.0	(19.9)
Phenylalanine	49.6	(8.3)	57.2	(14.8)
Lysine	68.8	(18.6)	76.2	(21.6)
Histidine	22.6	(3.9)	27.9	(6.1)
Arginine	59.9	(9.7)	61.0	(18.5)

* Mean live body weight ; chicken : 2772 g, duckling : 2892 g.

** Standard deviation - *Ecart-type.*

The apparent digestibilities of the amino acids found in the experimental diets are presented in table 4. Significant differences were found for the basal diet. Ducklings displaid higher digestibilities for all amino acids except tyrosine and histidine. Differences between the soyabean and cottonseed diets were fewer. In the soyabean diet the digestibilites of aspartic acid, lysine, arginine and histidine were higher in the ducklings. With respect to the cottonseed diet, no significant difference could be found.

TABLE 4

Apparent digestibilities of experimental diet amino acids.
Digestibilité apparente des acides aminés des régimes expérimentaux (p. 100).

	Basal diet		Soyabean diet		Cottonseed diet	
	Chicken	Duckling	Chicken	Duckling	Chicken	Duckling
Aspartic acid ..	69.3**	78.4	80.5	83.1	72.0	72.2
Threonine	65.1**	72.1	76.3	76.6	66.1	66.1
Serine	64.7**	70.7	79.0	77.8	77.1	78.8
Glutamic acid ..	80.4**	83.5	84.1**	86.8	82.8	81.6
Glycine	29.4*	44.8	56.9	56.9	60.5	57.9
Alanine	70.2*	76.8	70.5	66.9	66.6	67.6
Valine	63.9**	71.4	74.2	74.3	68.1	67.7
Isoleucine	64.3*	72.1	76.8	79.6	68.2	69.7
Leucine	76.7**	81.5	80.3	81.4	74.3	73.0
Tyrosine	68.5	70.6	80.9	80.3	70.0	70.4
Phenylalanine ..	74.2**	78.2	80.6	82.6	78.4	78.4
Lysine	59.5*	66.8	80.7**	85.5	64.3	65.9
Histidine	78.3	77.9	84.3*	86.6	78.7	79.1
Arginine	72.7*	77.9	82.9**	87.5	85.7	86.5

* Significant difference between chicken and duckling at 5 % level.
** Significant difference between chicken and duckling at 1 % level.

TABLE 5

True digestibilities of feedstuffs amino acids.
Digestibilité vraie des acides aminés des matières premières (p. 100).

	Soyabean diet		Cottonseed diet	
	Chicken	Duckling	Chicken	Duckling
Aspartic acid	90.7	91.7	84.0	78.7
Threonine	93.3	91.8	85.2	83.8
Serine	95.9	93.6	96.5	93.3
Glutamic acid	94.5	94.9	92.3	89.4
Glycine	80.2	64.6	83.8	72.1
Alanine	85.4	78.9	80.7	77.9
Valine	95.6	95.5	88.5	84.7
Isoleucine	91.0	90.8	84.4	81.8
Leucine	92.4	91.1	87.6*	82.0
Tyrosine	94.4	93.7	84.2	85.4
Phenylalanine	91.7	92.0	88.7	86.6
Lysine	96.9	99.0	80.7	78.7
Histidine	94.9	98.2	86.6	86.3
Arginine	94.5	96.9	92.5	91.5

* Significant difference between chicken and duckling at 5 % level.

The true digestibilities of the amino acids found in the pure feedstuffs are shown in table 5. Higher values were obtained for soyabean meal. Similar values were obtained for the two species for a given feedstuff. Slightly higher values were observed for lysine and arginine in ducklings fed on the soyabean diet, but they were not significant. The reverse was observed for leucine in the cottonseed diet.

IV. Conclusions

Although differences existed between experimental diets, particularly in the case of basal diet, the true digestibilities of amino acids are similar in domestic chicks and ducklings. The differences found previously in the apparent digestibility of total dietary protein are probably in part an artefact, which disappeared when calculations, excluding the effect of endogenous losses, were carried out on pure feedstuffs. The only difference between species occurred with diets where the apparent digestibility of total protein and the true digestibility of most amino acids were higher in ducklings than in chicks.

Consequently it seems to be justified to use the same amino acid digestibilities for ducklings and chicks.

Reçu en juillet 1985.
Accepté en janvier 1986.

Acknowledgment

Gérard GUY and Jean-Paul HARSCOAT are gratefully acknowledged for their excellent technical assistance.

Résumé

Digestibilité comparée des acides aminés chez le caneton de Barbarie et le poulet

Les digestibilités vraies des acides aminés du tourteau de soja et du tourteau de coton ont été mesurées chez le poulet et le caneton de Barbarie. Les pertes endogènes d'acides aminés ont été estimées chez des animaux recevant par gavage un régime sans protéines. Ces pertes endogènes sont très voisines chez les deux espèces. Des différences faibles mais significatives de digestibilité sont observées avec le régime de base, en faveur du caneton. La digestibilité vraie de la lysine et celle de l'arginine du tourteau de soja sont un peu supérieures chez le caneton. Celle de la leucine du tourteau de coton est un peu supérieure chez le poulet. Même si elles sont parfois significatives, les différences entre les deux espèces aviaires demeurent faibles. D'une manière générale les acides aminés du tourteau de coton sont nettement moins digestibles que ceux du tourteau de soja. On en conclut que d'un point de vue pratique on peut formuler les régimes destinés au canard avec les valeurs de digestibilité trouvées chez le poulet.

Mots clés : digestibilité, acides aminés, caneton de Barbarie, poulet.

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