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SUMMARY - The amino acid requirements of poultry are influenced by dietary, environmental and genetic factors. Therefore it is almost impossible to address all these factors in determining amino acid requirements. This problem can be overcome by expressing the amino acid requirements as ratios to lysine. In this concept it is assumed that the ideal ratio of amino acids to lysine remains largely unaffected by dietary, environmental and genetic factors. In this paper the present knowledge about the ideal amino acid profile in diets for layers and broiler chicks is discussed. Based on digestible amino acids, the ideal amino acid ratio relative to lysine in layer diets was estimated to be 84% methionine + cystine, 64% threonine, 18% tryptophan, 81% valine and 74% isoleucine. In broiler chick diets the ideal amino acid ratio relative to lysine was estimated to be approximately 75% methionine + cystine, 65% threonine, 18% tryptophan, 110% arginine, 80% valine and 70% isoleucine on a digestible basis.

Key words: Layers, broilers, amino acids, ideal profile.

RESUME - *"Profil idéal en acides aminés pour les volailles". Les besoins en acides aminés des volailles sont influencés par des facteurs diététiques, d'environnement et de génétique. Il est donc pratiquement impossible de faire face à tous ces facteurs pour les déterminer. Le problème peut être résolu en exprimant les besoins en acides aminés comme ratios de la lysine. Dans ce concept on suppose que le vrai ratio en acides aminés par rapport à la lysine n'est pas touché par des facteurs diététiques, d'environnement et génétiques. Nous présentons donc dans ce travail l'état des connaissances sur le profil idéal en acides aminés des régimes pour pondeuses et poulets de chair. Calculé sur une base d'acides aminés digestibles, le ratio idéal en acides aminés par rapport à la lysine dans les régimes pour pondeuses était estimé à 84% de méthionine plus cystine, 64% de thréonine, 18% de tryptophane, 81% de valine et 74% d'isoleucine. Dans les régimes pour poulets de chair, et toujours sur une base d'acides aminés digestibles, ce ratio était estimé à environ 75% de méthionine plus cystine, 65% de thréonine, 18% de tryptophane, 110% d'arginine, 80% de valine et à 70% d'isoleucine.*

Mots-clés : *Volaille, acides aminés, profil idéal.*

Introduction

Feeding strategy in pig and poultry production has been given a new perception with the advent of environmental problems related to pollution of nitrogen (N) from animal manure. Formerly, dietary adjustments to pig and poultry requirements were aimed at maximizing production performance without special concern for nutrient oversupply, especially protein and amino acids. The recent environmental constraints have forced to base protein/amino acid feeding not only on terms of N retained in animal products, but also in terms of non-utilized fraction of N ingested. Therefore, a sound management of protein feeding in poultry and pigs necessitates nowadays a close adjustment of protein/amino acid supply to the requirements so as to obtain the lowest level of N output.

In practical poultry diets methionine is the first limiting amino acid followed by lysine. Therefore, supplementation of methionine and lysine to practical poultry diets provides a means for increasing the efficiency of protein utilization, and as a result N excretion will be reduced. After these amino acids, threonine and in young chicks also glycine may often become limiting by reducing the dietary level of protein.

It is now generally accepted that the requirement for amino acids is proportionally linked to the requirement for the others. Increasing the supply of one amino acid will improve performance only if no other amino acid is limiting. During the last years more attention is paid to the ideal amino acid

profile in poultry diets. In the ideal concept for poultry as well as for pigs lysine is used as a standard, whereas the requirement for the other amino acids is expressed as a percentage of the need for lysine. This paper deals with our present knowledge about the ideal amino acid profile in layer and broiler chick diets.

Digestibility of amino acids

In many countries total amino acids are still used in composing poultry diets and for expressing the requirement. However, not all amino acids in the feed are available for maintenance and production. The part of amino acids that is not digested can differ very much between feedstuffs as is illustrated in Table 1. In this table, data are given for apparent faecal digestibility of protein and amino acids of some important feedstuffs. These data are used for composing poultry diets in Dutch practice. The results also show that digestibility of amino acids cannot simply be deduced from the digestibility of crude protein. Thus, digestible amino acids form a more satisfactory basis in formulating poultry diets than total amino acids.

Table 1. Apparent faecal digestibility of crude protein (CP) and amino acids in some feedstuffs for poultry†

Feedstuff	Protein content (%)	Digestibility (%)				
		CP	Lys	Met	Cyst	Thr
Maize	8.7	84	61	88	75	75
Barley	10.7	70	65	75	70	67
Oats	11.2	75	60	76	64	63
Wheat	11.9	81	84	89	84	79
Sorghum	10.1	72	55	69	65	44
Peas	20.6	87	83	87	75	81
Soyabean meal	45.0	86	87	85	81	83
Sunflower meal	34.0	85	85	81	76	94
Rapeseed meal	34.3	76	80	84	70	78
Meat meal	58.6	80	78	78	69	76
Fish meal	66.0	88	91	93	89	85

†Data provided by the Dutch Bureau of Livestock Feeding (1994)

Ideal amino acid profile

It is well recognized that the requirement for amino acids cannot apply to all birds under all dietary, sex and body compositional circumstances. This problem can be overcome by expressing the amino acid requirements as ideal ratios to lysine. In this ideal amino acid concept it is assumed that the ideal ratio of indispensable amino acids to lysine remains largely unaffected by dietary, environmental and genetic factors. However, accurate lysine requirement figures under a variety of circumstances should be available by expressing the requirement for other amino acids in % of lysine.

Laying hens

Some years ago a research project was started in the Netherlands to obtain more information about the requirement of the most important amino acids for white egg layers. Based on the results of this project and literature data the requirements for lysine, methionine, methionine + cystine (SAA), threonine, tryptophan, valine and isoleucine were estimated on basis of apparent faecal digestible amino acids. These data were published in a report of the Dutch Bureau of Livestock Feeding,

CVB (1996). The recommended dietary intakes for apparent faecal digestible amino acids by CVB (1996) at a daily egg mass production of approximately 55 g/hen are summarized in Table 2. In addition the corresponding dietary intakes for total amino acids are presented in this table.

Table 2. Recommended dietary intakes of amino acids for white egg layers by CVB (1996)

Amino acid	App. faecal dig. amino acids		Total amino acids†	
	mg/hen/day	% of lys	mg/hen/day	% of lys
Lysine	700	100	890	100
Methionine	350	50	400	45
Meth. + cystine	650	93	750	84
Threonine	460	66	570	64
Tryptophan	130	19	160	18
Valine	600	86	720	81
Isoleucine	550	79	660	74

†Based on a maize-soya diet supplemented with 0.20% DL-methionine

The figures in Table 2 show that on a digestible basis for most of the amino acids other ratios are achieved than when based on total. This is the result of the differences in digestibility among the amino acids (Table 1). Further it should be noted that the digestibility of the added methionine to the diet was assumed to be 100%. This also results in an increase of the ratios for methionine and SAA when based on a digestible basis.

The recommended dietary intakes for total amino acids of CVB (1996) differ considerably from those suggested by NRC (1994). The estimated requirement figures by NRC (1994) of the amino acids listed in Table 2, are summarized in Table 3. For the most important amino acids (lysine, methionine and SAA) the requirement figures of NRC (1994) are considerably lower than those estimated by CVB (1996). As a result there are also quite large differences in amino acid ratios between those given by NRC (1994) and CVB (1996). However, it should be noted that the requirement figures recommended by NRC (1994) are mainly based on USA studies in which egg production criteria rather than feed conversion efficiency were used in estimating the amino acid requirements. There is ample evidence that for obtaining maximum efficiency of feed utilization the requirement for methionine and SAA is higher than for obtaining maximum egg mass yield (Janssen, 1974; Schutte and van Weerden, 1978; Schutte *et al.*, 1983, 1984, 1994). The same seems to be true for lysine (Schutte and Smink, 1998a). Both egg mass and feed utilization were used in estimating the amino acid requirement of laying hens by CVB (1996).

Table 3. Recommended dietary intakes of amino acids by NRC (1994)†

Amino acid	Requirement in mg/hen/day	% of lysine
Lysine	690	100
Methionine	300	43
Meth. + cystine	580	84
Threonine	470	68
Tryptophan	160	23
Valine	700	101
Isoleucine	650	94

†On a total basis for white egg layers with a daily egg mass production of approximately 50 g

Broiler chicks

There are several published recommendations about the ideal amino acid profile in broiler chick diets. The most recently published data are summarized in Table 4. The results in Table 4 show that for some amino acids there are quite large differences between the ratios suggested by Baker *et al.* (1993), NRC (1994), Baker (1996), Austic (1994) and CVB (1996). Part of this discrepancy might be explained by the basis used. The ratios suggested by NRC (1994) and Austic (1994) are based on total amino acids, whereas those of Baker *et al.* (1993), Baker (1996) and CVB (1996) are calculated on a digestible amino acid basis. In addition, the calculated ratios are based on different dietary levels of lysine. The amino acid ratios suggested by Baker *et al.* (1993) and Baker (1996) are based on a true digestible lysine level of 1.07% from 0 to 21 d and of 0.81% from 21 to 42 d. These levels correspond with approximately 1.22 and 0.98% total lysine, respectively, in a maize-soya based diet. The NRC (1994) amino acid ratios are based on a total lysine level of 1.10% from 0 to 21 d and 1.00% from 21 to 42 d. The calculated amino acids ratios of Austic (1994) are also based on total amino acids by assuming a requirement of 1.30% total lysine. The amino acid ratios suggested by CVB (1996) are based on lysine levels recommended by Schutte and Smink (1998b). These investigators studied the requirement for apparent faecal digestible lysine during the age period of 0 to 14, 14 to 28 and 28 to 42 days by using a maize-soya based diet. The diets used contained 13.2 MJ AME_n/kg in the age period of 0 to 14 d and 13.4 MJ AME_n/kg in the age period of 14 to 42 d. Their estimated requirement figures for apparent faecal digestible lysine during these age periods were 1.05, 1.00 and 0.95%, respectively. These values corresponded with approximately 1.25, 1.20 and 1.15% total lysine, respectively.

Table 4. Published data about the ideal amino acid profile for broiler chicks

Amino acid	Baker (1993,1996)		NRC (1994)		Austic (1994)	CVB (1996)
	0-21 d	21-42 d	0-21 d	21-42 d	0-21 d	0-42 d
Lysine	100	100	100	100	100	100
Methionine	36	36	45	38	38	38
Meth. + cystine	72	75	82	72	72	73
Threonine	67	70	73	74	62	65
Arginine	105	108	114	110	96	105
Valine	77	80	82	82	69	80
Isoleucine	67	69	73	73	65	66
Leucine	109	109	109	109	92	ND
Tryptophan	16	17	18	18	18	16
Histidine	32	32	32	32	24	ND

ND: Not determined

In 1995 an European research project was started for obtaining more information about the ideal ratios of the amino acids lysine, methionine + cystine, threonine, tryptophan, arginine, valine and isoleucine and to assess the adequate dietary lysine level for optimum performance in broiler chicks during the age period of 20 to 40 days. Three research institutes (INRA, France, Rijksstation voor Kleinveeteelt, Belgium and ILOB-TNO, The Netherlands) were involved in this project. Each amino acid was tested in six graded dietary levels by using an identical basal diet containing 17.2% CP and 13.2 MJ AME_n/kg. For each experiment the basal diet was adequately supplemented with non-essential and essential amino acids except for the essential amino acid tested. The parameters studied included weight gain, feed conversion efficiency and breastmeat yield. Based on these parameters the ideal amino acid ratio relative to lysine (on basis of true faecal digestible amino acids) was calculated by using the broken-line regression analysis. The ideal ratio relative to lysine was found to be 75% for methionine + cystine, 63% for threonine, 19% for tryptophan, 112% for arginine, 81% for valine and 71% for isoleucine. The lysine concentration for obtaining maximum feed utilization was estimated to be 1.15% true faecal digestible lysine for the age period of 20 to 40 days at a AME_n content of 13.2 MJ/kg. This value for true faecal digestible lysine corresponded with 1.22%

total lysine. This value corresponds well with the requirement figure reported by Schutte and Smink (1998b) of 1.20% total lysine for the age period of 14 to 28 days.

Considering the results of the European research project, it appears that the estimated amino acid ratios for most of the amino acids agree well with those suggested by CVB (1996). Higher ratios for arginine and tryptophan were estimated in the studies of the European research project than those suggested by CVB (1996). The complete results of the studies carried out in the framework of the European research project will be published by Mack *et al.* (1998). Thus based on the published data the ideal amino acid ratio relative to lysine can be estimated to be approximately 75% for SAA, 65% for threonine, 110% for arginine, 18% for tryptophan, 80% for valine and 70% for isoleucine on a digestible basis.

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