STANDARDISED ILEAL DIGESTIBILITY – PROPOSAL FOR A NEW SYSTEM TO DESCRIBE AMINO ACID DIGESTIBILITY OF FEED INGREDIENTS FOR POULTRY

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Summary

Ileal amino acid digestibility is a more sensitive approach to describe the protein quality of feed ingredients than excreta digestibility values. The relative merits of apparent and true digestible amino acid systems are discussed. The concept of standardised digestibility system as a mean of overcoming the limitations of apparent digestibility estimates is proposed. But transformation of apparent ileal digestibility values to standardised ileal values will require reliable information on estimates of basal endogenous amino acid losses at the ileal level in growing poultry and further research is warranted in this area.

I. INTRODUCTION

It is now widely accepted that caecal fermentation in poultry has significant modifying effects on protein digestion and that amino acid digestibility in feed ingredients for poultry should be determined at the ileal rather than excreta level (Ravindran et al., 1999). However, most published values currently available, including several compilations (Sibbald, 1986; Parsons, 1991; Rhone-Poulenc, 1995; NRC, 1994; Heartland Lysine, 1996), on digestible amino acids for poultry are based on excreta analysis. All these values have been determined with adult cockerels using the rapid assay procedure of Sibbald (1979) or modifications thereof. The attraction of this rapid assay had been its simplicity and the assay can be carried out on a large number of birds without sacrificing the birds. These values are generally applied to all classes of poultry, including growing birds. In contrast, published values on ileal amino acids digestibility values in feed ingredients are limited. Only one database on ileal amino acids digestibility for broiler chickens exists (Ravindran et al., 1998), along with sporadic publications reporting ileal digestibility values for selected ingredients.

A major problem faced by the users of digestible amino acids databases is the considerable confusion that exists about the terminology used to describe the amino acids digestibility estimates. For each amino acids in a feedstuff, there are at least five possible values to describe the digestibility for poultry: apparent or true for excreta (from intact or caecectomy) or ileal digestibility (Ravindran and Bryden, 1999). In particular, the issue that is often debated is which ileal digestible amino acids system is most appropriate for use in diet formulations - apparent or true digestibility values.

II. APPARENT VERSUS TRUE DIGESTIBILITY

Ileal digestibility of amino acids can be expressed as apparent digestibility or as true digestibility. The difference between these two expressions arises from whether or not the digestibility estimates are corrected for endogenous losses of amino acids. Apparent digestibility measures the digestibility of amino acids of both dietary and endogenous origins. True digestibility, on the other hand, includes a correction for endogenous amino acids secretions, and is considered to be a fundamental characteristic of the feedstuff that is relatively constant across varying dietary protein levels. Therefore the use of true digestibility data permits feed ingredients to be compared even if they are assayed under varying dietary conditions.

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The need for correction of endogenous amino acids losses in amino acids digestibility estimates has been debated for many years both by poultry and pig nutritionists. The proponents of apparent digestibility system argue that as there is no reliable method for measuring endogenous secretions under a given dietary situation, a system based on apparent digestibility is a better practical basis for diet formulations. It is also argued that correcting apparent digestibility for endogenous losses can introduce artefacts and mask important differences between feed ingredients. Although digestibility is often considered to be a characteristic of a diet or feed ingredient, it is, in reality, the property of the ingredient in relation to the animal to which the diet is given. The contention is that if a feed ingredient increases endogenous amino acids flow out of the small intestine, that represents a loss to the animal and must be realistically ‘charged’ against the feed ingredient as lowered amino acids digestibility.

Nevertheless, it should be noted that there are some drawbacks in using apparent digestibility data in diet formulations. First, the additivity of apparent digestibility values of individual ingredients when combined in diet formulations remains questionable. Though the additivity of apparent digestibility values has been demonstrated by some studies (Angkavanakorn et al., 1996; Bryden and Li, 2003), further research on this topic is needed, since there may be associative effects especially when high levels of poorly digestible ingredients are used. Second, for feedstuffs with low protein content (e.g. cereals, grain legumes), the apparent digestibility values are underestimated relative to feedstuffs with high protein content because of the relatively greater proportion of endogenous amino acids in the digesta or excreta. Especially those amino acids present at low levels in cereals or grain legumes (e.g. lysine, threonine and tryptophan) and those present in high levels in endogenous protein (e.g. threonine) will be affected. Third, the applicability of ideal protein concept in formulation based on apparent digestibility estimates is another limitation. Because of the way in which ideal protein ratios are determined, the patterns reflect true digestibility rather than apparent digestibility (Baker, 1996).

III. ILEAL ENDOGENOUS AMINO ACID LOSSES

The reliability of available methods (Table 1) for determining endogenous amino acids losses, under a given set of dietary circumstances, had been the major issue limiting the usefulness of true digestibility estimates. All the available methods of determining endogenous losses have specific applications and shortcomings (see review, Ravindran and Bryden, 1999).

Table 1. Methods used for the determination of endogenous amino acid flows in poultry.

- Fasting of birds for 24 to 48 hours
- Feeding of protein-free diet
- Linear regression, following feeding of diets containing graded levels of protein
- Guanidinated dietary protein
- Enzyme hydrolysed casein and ultrafiltration
- Feeding of highly digestible protein, e.g. wheat gluten

\(^1\) Used only to measure flows in the excreta.

It is now recognised that endogenous amino acids losses are influenced primarily by dry matter intake and secondarily by the inherent composition of the feed ingredient or diet (i.e. fibre level, presence of anti-nutritional factors, etc). These two fractions are referred to
as basal (also known as non-specific) and specific endogenous amino acids losses, respectively. Basal endogenous losses can be defined as those inevitable losses closely associated with the metabolic functions of the animal and are independent of the diet type. These losses, therefore, represent the minimum losses that can be expected under any feeding situation.

IV. STANDARDISED ILEAL DIGESTIBILITY VALUES

The limitations of apparent ileal digestibility values, discussed above, could be overcome by standardising these estimates through corrections for basal endogenous losses, as shown below:

\[
\text{SID} = \text{AID} + \text{Basal endogenous amino acid flow (g/kg DMI)}
\]

\[
\text{Amino acid content of the ingredient (g/kg DM)}
\]

Where SID = standardised ileal digestibility values, AID = apparent ileal digestibility values and DMI = dry matter intake.

The SID values are independent of the method by which the AID were originally estimated and, more importantly, additive when used in practical feed formulation. This proposal to convert AID values to SID values is not a new concept. Boisen and Moughan (1996) were among the first to suggest such transformations for the pig industry. Tabulated SID of protein and amino acids in common feed ingredients for pigs have recently become available (Rademacher et al., 1999; Amipig, 2000; Pedersen and Boisen, 2002), wherein published apparent digestibility values have been transformed to standardised values using existing literature data on endogenous amino acid recovery in ileal digesta.

The obvious advantage of the proposed system, as against the ‘conventional true digestibility’ assay, is that apparent digestibility and endogenous losses need not be determined in the same experiment. Standardised ileal digestibility values of ingredients for poultry can be calculated for published apparent digestibility values in the literature, but this will require an estimate of the amount of basal endogenous protein and amino acid recoveries in ileal digesta.

V. ESTIMATION OF BASAL ILEAL ENDOGENOUS LOSSES

Compared to pigs, where the literature abounds with data on ileal endogenous amino acid losses, there is a paucity of corresponding information in poultry. Clearly further research and more data are needed to obtain reliable estimates of basal ileal endogenous losses in poultry. Only when sufficient data becomes available, will it be possible to agree on a valid estimate of basal losses at the ileal level. In the case of pigs, there has been much recent discussion about how to define basal endogenous losses and how this should be determined. While some accept values following the feeding of protein-free diets as valid estimates of basal losses (Jondreville et al., 1995), others have averaged across data determined using different methods (protein-free diet, regression and use of highly-digestible proteins such as enzyme hydrolysed casein and wheat gluten) and calculated a weighted mean, as a measure of basal losses (Rademacher et al., 1999; Pedersen and Boisen, 2002).
VI. CONCLUSIONS

A new system to describe amino acid digestibility in feed ingredients for poultry is proposed. It is suggested that the development of tabulated values of SID values offers the opportunity for the poultry industry to further improve the precision of diet formulations. The transformation of available AID values to SID values, however, requires reliable information on basal endogenous amino acid losses and further research is warranted in this area.

REFERENCES