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REGULAR ARTICLE

THE EFFECT OF BODY WEIGHT OF PIGS ON TRUE AND APPARENT ILEAL AMINO ACIDS DIGESTIBILITY OF RYE

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ABSTRACT

It is generally accepted that the ability of pigs to digest protein increases with age. However, it has been shown that small pigs excreted more endogenous nitrogen (N) than large pigs. Consequently, the apparent amino acids (AA) digestibility may be lower in young pigs while true digestibility, which is corrected for endogenous losses, may be comparable with that found in older pigs. To test this hypothesis, six cannulated piglets (mean body weight 20.6 kg) fitted with a simple T-cannula at terminal ileum were used to estimate apparent and true digestibilities of AA and of total N in a rye-based diet (96 % rye). The digestibility study was repeated on the same pigs fed the same diet when they reached mean body weight 61.7 kg. The apparent ileal digestibilities of total AA and total N were significantly higher in heavier pigs than in piglets. Except for methionine and phenylalanine, the apparent digestibilities of individual AA showed a similar pattern. In contrast, there was no significant difference between piglets and heavier pigs for the true ileal digestibility of total N. True digestibility of most AA was lower in heavier pigs than in piglets, the differences for total and some individual AA being significant. The present results suggest that the higher apparent digestibility values found in heavier pigs as compared to piglets are due to the confounding effect of endogenous N losses rather than the better ability of older pigs to digest protein.

Keywords: apparent and true ileal digestibility, body weight, nitrogen, amino acids, pig

INTRODUCTION

The ability of pigs to digest protein increases with age **(Fernández *et al*., 1986; Etienne *et al*., 1997).** This fact was attributed to the microbial activity of the large colon which was shown to be higher in older animals **(Shi and Noblet, 1993).** The longer transit time of digesta along the small intestine in older pigs, higher secretion rate or activity of digestive enzymes or a relative decrease in endogenous AA losses with advancing age are other factors, which may be involved in the processes of protein digestion and absorption. **Leterme and Théwis (2004)** studied the effect of body weight of pigs on ileal flow of endogenous AA and found that small pigs excreted more endogenous N than large pigs (expressed per kg dry matter intake). It means that the apparent AA digestibility may be lower in young pigs while true digestibility, which is corrected for endogenous losses, may be comparable with that found in older pigs.

The objective of our study was to compare apparent and true ileal digestibility of AA and of total N in pigs at two body weights (20.6 and 61.7 kg) fed a rye-based diet.

MATERIAL AND METHODS

Six Large White young cannulated gilts (mean body weight 20.6 kg) fitted with a simple T-cannula at terminal ileum were housed in metabolic cages and fed a rye-based diet. The composition of experimental diets and nutrient contents are given in Table 1. Chromic oxide was added to the diets as an indigestible marker. The digestibility study consisted of a 6-day preliminary period followed by a 24-h collection period. During the collection period, samples of ileal digesta were collected in polyethylene bags attached to the cannula barrel in one-hour intervals. Digesta samples were acidified with 6M H_2SO_4 to pH 3.5, pooled and freeze-dried for subsequent analysis of AA, total N and Cr_2O_3.

The digestibility study was repeated on the same pigs fed the same experimental diet when they reached mean body weight 61.7 kg. In both parts of the study, the pigs were fed twice daily at 7.00 and 16.00 hours in two equal meals at a daily rate of 90 $g/kg^{0.75}$. Water was offered ad libitum. All experimental procedures were reviewed and approved by the Ethical Committee of the Animal Production Research Centre Nitra. Coefficients of apparent ileal digestibility of AA and N were calculated using the following formula:

$$\text{Digestibility (\%)} = 100 \times [1-(N_i \times C_d)/(N_d \times C_i)]$$

where N_d = dietary concentration of the nutrient under study, C_d = dietary concentration of Cr_2O_3, N_i = concentration of the nutrient in ileal digesta and C_i = concentration of Cr_2O_3 in ileal digesta (all values in $g.kg^{-1}$ dry matter). For the estimation of true digestibility, ileal concentrations of AA and of total N were corrected for endogenous losses.

Table 1 Composition of the basal diet ($g.kg^{-1}$, air-dry basis)

Component	**$g.kg^{-1}$**
Rye	958.0
Soyabean oil	9.0
Monocalcium phosphate	11.0
Limestone	13.0
Salt	3.0
Cr_2O_3	3.0
Premix[1]	3.0
Chemical analysis	
Dry matter	900.3
Crude protein	136.7
Ether extract	26.3
Ash	43.6
Crude fibre	28.6

[1] Supplied per kg of diet: vit. A, 7200 IU; vit. D3, 1350 IU; α– tocopherol 18 mg; vit. B1, 0.54 mg; vit. B2, 3.6 mg; vit. B6 19.5 mg; Ca-pantothenate, 10.5 mg; niacin, 15 mg; vit. K3, 0.54 mg; biotin, 0.06 mg; cyanocobalamin, 0.021 mg; choline, 102 mg; betaine, 51 mg; Fe, 60 mg; Zn, 90 mg; Mn, 42 mg; Cu, 21 mg; I, 0.42 mg; Co, 0.54 mg; Se, 0.21 mg.

The significance of differences between digestibility values at two body weights was evaluated by a paired t-test using Statgraphic Plus package v. 3.1.

RESULTS AND DISCUSSION

The data on apparent and true ileal digestibilities of AA and of total N are summarized in Table 2. Except for methionine and phenylalanine, the coefficients of apparent digestibility

of AA and total N were higher in older pigs than in piglets. The apparent ileal digestibility in older pigs was on average about 6 % higher than in piglets. The differences for total AA, total N as well as for most individual AA were significant (P<0.05). The highest digestibility values were found in glutamic acid and arginine while the digestibility of glycine was very low, which is in accordance with other similar studies (**Barrera *et al.*, 2004; Diebold *et al.*, 2004; Nitrayová *et al.*, 2006**).

Table 2 Apparent and true ileal digestibility of amino acids and total N (%)

Amino acid	Ileal digestibility				Pooled
	Apparent		True		
	20.6 kg	61.7 kg	20.6 kg	61.7 kg	SEM
Total N	62.3	67.0 *	78.5	75.2	1.0
Arginine	78.8	82.3 *	86.0	85.3	0.6
Histidine	70.5	72.8	81.2	77.2 *	1.2
Isoleucine	68.2	70.8	80.2	78.7	1.4
Leucine	74.5	78.8 *	89.8	85.3 *	1.2
Lysine	66.7	71.2 *	84.5	80.0 *	1.4
Methionine	74.5	74.2	98.0	86.7 *	1.2
Phenylalanine	75.3	75.0	86.2	82.2	1.9
Threonine	62.8	69.0 *	82.5	78.3	1.7
Valine	68.7	71.8 *	83.8	79.3 *	1.6
Alanine	59.0	62.8	87.8	74.8 *	1.8
Aspartic acid	68.8	72.0 *	83.7	79.3 *	1.1
Cystine	63.0	68.8	95.2	87.2 *	2.3
Glutamic acid	85.8	88.1 *	89.8	90.7	0.8
Glycine	47.3	55.0	72.7	67.3	2.3
Proline	71.2	71.7	89.5	79.2	4.1
Serine	68.2	74.5 *	93.8	87.5 *	1.2
Tyrosine	60.2	78.5 *	75.3	89.0 *	2.0
Total amino acids	68.1	72.5 *	85.5	81.3	1.0

* Significant difference (P<0.05)

The comparison of true digestibility data for both body weight groups gave opposite results. The digestibility of most AA was higher in piglets than in heavier pigs, the only exception being glutamic acid and tyrosine. Although the effect of body weight was

significant in nine out of seventeen AA, no significant difference was found for total AA or total N. The digestibility of total N in piglets was about 4 % higher than in heavier pigs. The difference between apparent and true ileal digestibility of total N in piglets was 26 %. It is interesting to note that a much larger difference (54 %) was observed in glycine, presumably due to the high concentration of this AA in endogenous protein (**de Lange *et al.*, 1989; Hodgkinson *et al*., 2000**).

The present results suggest that the young pigs weighing about 20 kg possess sufficient capacity to digest protein. The low apparent AA digestibility reported in the literature might have been an underestimation resulting from the relative high endogenous N losses in young animals. It has been generally postulated that endogenous N losses present a constant fraction of dry matter intake (**Butts *et al.*, 1993**), being independent on body weight (**Furuya and Kaji, 1999; Stein *et al.*, 1999**). However, the results of experiments studying specifically the effect of body weight on endogenous N and AA losses in pigs clearly showed that when expressed per kg dry matter intake, endogenous losses decreased with increasing body weight (**Hess and Sève, 1999; Leterme *et al*. 2000; Leterme and Théwis, 2004**). This fact may be explained by higher protein turnover of intestinal tissue of young pigs as compared to older ones (**Leterme and Théwis, 2004**) or by higher absorptive capacity of older animals (**Buddington, 1997**), leaving minimum endogenous protein in the small intestine.

CONCLUSION

On average, slightly higher true AA digestibility values were found in piglets than in older pigs. The lower apparent digestibility found in piglets as compared to older pigs might have been an underestimation resulting from the relative high endogenous N losses in young animals. With regard to a small number of papers studying this area further experiments are needed to obtain reliable information on the effect of body weight on ileal digestibility and endogenous AA losses.

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