

Comparative amino acid digestibilities in adult sows and growing pigs.

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Abstract

An experiment involving twelve growing pigs and twelve adult sows was conducted in order to compare apparent ileal amino acid digestibilities between growing pigs, gestating sows, and lactating sows. Six different feed ingredients were tested. Growing pigs and lactating sows were given ad libitum access to feed whereas gestating sows were fed only 2 kg of feed per day. Results from the experiment showed that apparent ileal digestibilities of all indispensable amino acids except arginine are higher in lactating sows than they are in growing pigs ($P < 0.05$). Also gestating sows had higher apparent ileal digestibilities than had growing pigs, however only for the sulfur containing and the branched chained amino acids were the differences significant ($P < 0.05$). The results from the experiment indicate that values for apparent ileal digestibilities obtained with growing pigs are not representative for gestating and lactating sows.

Introduction

Digestibilities of individual amino acids in growing pigs have been determined for a broad range of feed ingredients. Several different techniques have been used, but measurements of the apparent ileal digestibilities provide the most appropriate values, as they take into account the endogenous cost of digestion (Batterham *et al.*, 1994). Using this technique, it is generally assumed that amino acids not absorbed at the terminal ileum are not going to be available for the animal. It is assumed that the microbes in the large intestine will incorporate them into microbial protein, which is excreted in the feces, or they will be deaminated with a subsequent production and absorption of urea which is excreted in the urine (Just *et al.*, 1981). Easter and Tanksley *et al.*, (1973) developed and described a technique to measure apparent ileal digestibility in pigs using an indwelling re-entrant cannula installed across the ileocecal juncture. This technique has since been modified, and today, a simple T-cannula inserted five to ten cm anterior to the ileocecal valve is most often used for ileal collections (Sauer and de Lange *et al.*, 1992). Accuracy and a minimal trial-to-trial variation in the values obtained by using this technique is the main reason for its popularity (Knabe *et al.*, 1989).

Nitrogen digestibility in sows has been determined in only a few studies. Noblet and Shi *et al.*, (1993) compared apparent fecal nitrogen digestibilities in adult, dry sows with those obtained in ad libitum fed growing pigs and found that the sows had a higher apparent fecal nitrogen digestibility. Working with growing pigs, (Roth and Kirchgessner *et al.*, 1984) reported that apparent fecal nitrogen digestibilities increased with age. Fernandez *et al.*, (1986) found apparent fecal nitrogen digestibilities in adult, dry sows to be considerably higher than in growing pigs. In the same study, no significant differences in fecal nitrogen digestibilities were found between different feeding levels given to the sows, indicating that also when sows are fed near ad libitum, as is the case during lactation, nitrogen digestibility might be higher than in growing pigs. Haydon *et al.*, (1984) used growing pigs to study the effect of feeding level on apparent digestibilities. In agreement with the results of (Fernandez *et al.*, 1996), they found feeding level to have only a limited influence on amino acid digestibilities as measured over the total gastrointestinal tract. However, when measurements were taken at the end of the terminal ileum, they found a tendency for increased digestibility with increasing feeding level.

Values for apparent ileal amino acid digestibilities in growing pigs for different feed ingredients have been summarized by (Sauer and Ozimek *et al.*, 1986 and Knabe *et al.*, 1990). When apparent ileal digestibilities are used in feed formulation or modeling, these values are usually applied to all categories of pigs. However,

several physiological factors, i.e. age, body weight, feeding level, and immunological status, have been shown to influence the degree to which an animal can digest amino acids in a given diet (Moughan *et al.*, 1991 and Williams *et al.*, 1995). Since adult pregnant or lactating sows differ considerably from growing pigs in this regard, inaccuracies may be associated with applying values obtained with growing pigs to sows. We are aware of no studies in which apparent digestibilities of individual amino acids have been determined for gestating or lactating sows.

It was the objective of the present experiments to compare apparent ileal digestibilities of individual amino acids in growing pigs and adult, gestating and lactating sows, to test the hypothesis that values for amino acid digestibilities in sows are the same as in growing pigs.

Materials and methods

Animals and experimental design. Twelve adult, pregnant multiparity sows (PIC, Camborough 15, Pig Improvement Company, Franklin, KY) and twelve growing barrows (PIC, Camborough 15 dams sired by PIC 326 boars, Pig Improvement Company, Franklin, KY) of approximately 40 kg body weight were used in the experiment. Sows and pigs were surgically fitted with simple T-cannulae in the terminal ileum using the technique described by (Stein and Easter *et al.*, 1996). The sows were cannulated at day 40 of gestation. Six sows and six growing pigs were arranged in a repeated three by three latin square and fed three cereal grains (corn, barley, and wheat). The remaining six sows and six pigs were also arranged in a repeated three by three latin square and fed three protein ingredients (soybean meal, canola and meat and bone meal). Sows were fed the test diets during gestation as well as lactation.

Diets and feeding. The six experimental diets used in this experiment are shown in table 1. Glutamate and glycine were added to the cereal grain diets to give an equivalent of 13 % crude protein in order to provide sufficient nitrogen for the synthesis of dispensable amino acids. (Henry *et al.*, 1992). Synthetic amino acids were added wherever needed to meet the NRC requirements for indispensable amino acids for lactating sows (NRC, 1988). Vitamins and minerals were supplied to meet NRC requirements (NRC, 1988). Chromic oxide was included in the diets at a level of 0.25 %.

Each feeding period consisted of 7 days. The initial five days of each period was considered an adaptation period. During two twelve hour periods on day six and day seven, ileal digesta were collected from the animals. Sows were fed two kg of feed per day during pregnancy, whereas growing pigs and lactating sows were allowed ad libitum intake of feed.

Sample analysis. Digesta were frozen immediately after collections. At the end of the experiment, samples for each animal and diet were thawed and mixed, and a subsample was taken and frozen again. Prior to chemical analysis, samples were freeze dried and ground through a coffee grinder. Approximate analysis was performed according to AOAC procedures (AOAC, 1990). Amino acid contents were determined with an HPLC amino acid analyzer after hydrolysis with 6 N hydrochloric acid under reflux at 110 °C for 24 hr. The sulfur containing amino acids were analyzed after oxidation with performic acid and subsequent hydrolysis with HCL. Tryptophan was determined by HPLC after alkaline hydrolysis using barium hydroxide at 125 °C for 16 hr. The content of chromium in feed and digesta was determined by atomic spectrophotometry according to the method outlined by (Williams *et al.*, 1962).

Calculations and statistical analysis. The apparent ileal digestibility of each indispensable amino acid was calculated as described by (Fan *et al.*, 1995). It was assumed that the dietary contents of synthetic amino acids were completely absorbed (Chung and Baker *et al.*, 1992), and only the amino acids originating from the feed ingredients were used in the calculations. Analysis of variance of data were conducted using the proc GLM function in SAS (SAS, 1990).

Results and discussion

Results from the experiment are presented in table 2. Only the combined results across all feed ingredients are presented here. (Differences between the feed ingredients tested were detected and will be discussed at the Swine Summit).

Table 2. Apparent ileal digestibilities of amino acids in growing pigs and sows*

	Lactating sows	Gestating Sows	Growing Pigs	s.e.
All AA	72.37	69.66	68.95	1.34
Indisp. AA	76.28 ^a	72.96 ^b	70.35 ^b	1.13
Lysine	73.73 ^a	65.85 ^b	62.77 ^b	1.54
Tryptophan	77.7 ^a	66.6 ^b	63.54 ^b	1.87
Threonine	66.22 ^a	61.25 ^b	59.13 ^b	1.69
Methionine	80.36 ^{ab}	81.66 ^a	78.66 ^b	0.82
Met. + Cys.	77.73 ^a	77.31 ^a	74.23 ^b	0.98
Valine	75.07 ^a	73.56 ^a	70.19 ^b	1.18
Isoleucine	75.24 ^a	75.46 ^a	71.77 ^b	1.05
Leucine	79.45 ^a	77.79 ^a	75.17 ^b	1.03
Phenylalanine	77.54 ^a	73.39 ^b	69.88 ^c	0.96
Histidine	75.91 ^a	72.97 ^b	71.78 ^b	1.09
Arginine	81.5	81.02	80.62	0.77

* Numbers with different superscripts are significantly different ($P < 0.05$).

The apparent ileal digestibilities of all indispensable amino acids except arginine were higher in lactating sows than in growing pigs ($P < 0.05$). Likewise, digestibilities of all amino acids in gestating sows were higher than in growing pigs, but only differences for the sulfur containing amino acids and the branched chained amino acids were significant ($P < 0.05$). Lactating sows had higher digestibilities than had gestating sows with the differences for lysine, tryptophan, threonine, phenylalanine and histidine being significant ($P < 0.05$).

The reason for the increased digestibilities in sows as compared to growing pigs is unknown. Both lactating sows and pigs were fed ad libitum, hence differences due to different levels of feed intake are not likely to have influenced the results obtained with these two groups. Unpublished results from our laboratory suggests that the levels of endogenous losses of amino acids at the terminal ileum in sows and pigs are not significantly different if the animals are given ad libitum access to feed. Therefore, the observed difference in apparent ileal digestibility between lactating sows and pigs is most likely a true difference in the amounts of amino acids digested and absorbed prior to the terminal ileum. A physiological mechanism that triggers an increase in digestion and absorption of amino acids during lactation may exist, however, at this point no data exist to support such a speculation.

The apparent digestibility of most amino acids also was higher in lactating sows than in gestating sows. It was previously shown that restrictedly fed sows have an increased loss of endogenous amino acids at the terminal ileum as have sows given ad libitum access to feed (Stein and Easter, unpublished results), hence differences in endogenous losses of amino acids at the terminal ileum may - at least partly - be responsible for the observed difference in apparent digestibility. Therefore, the difference in true amino acid digestibility between lactating and gestating sows is smaller than the values for apparent digestibilities would indicate.

In conclusion, the experiment showed that apparent amino acid digestibilities in sows are higher than in growing pigs. These differences need to be taken into account in feed formulations and modelling. Furthermore, the growing pig seems to be a relatively poor model for predicting amino acid digestibilities in sows. Further research in the area is needed in order to identify the mechanisms responsible for the increased digestibility in sows.

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