Endogenous secretions of protein and amino acids in pregnant and lactating sows

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Summary

Digesta appearing at the terminal ileum were collected from ten *ad libitum* fed growing pigs, five *ad libitum* fed lactating sows, five gestating sows fed 2 kg of feed per day, and four *ad libitum* fed gestating sows after feeding a nitrogen free diet. The results indicate that age, bodyweight, and physiological stage have little or no effect on the amount of endogenous protein and amino acids secreted in pigs if calculated as g/kg DM intake. However, daily feed intake has a significant effect on endogenous protein and amino acid losses in sows. It is concluded that values for endogenous secretions obtained with growing pigs can be applied to sows if the feeding regime is the same.

Keywords: endogenous amino acid, protein, sow, gestation, lactation

Résumé

Sécrétions endogènes de protéines et d'acides aminés chez la truie gravide ou allaitante. La collecte de digesta au niveau le l'iléon terminal a été réalisée sur dix porcs en croissance nourris à volonté, cinq truies allaitantes et quatre truies gravides nourries à volonté, et cinq truies gravides rationnées. Tous les animaux recevaient un régime protéiprive. Les résultats montrent que l'âge, le poids et le stade physiologique n'ont pas d'effet sur les sécrétions endogènes d'acides aminés et de protéines, lorsque les calculs sont effectués par kg de matière sèche ingérée. Par contre, la prise alimentaire a un effet sur les sécrétions endogènes de protéines et d'acides aminés. Les valeurs de sécrétions endogènes obtenues chez le porc en croissance peuvent donc être utilisées pour la truie si le régime alimentaire reste le même.

Mots clés: acide aminé endogène, protéine, truie, gestation, lactation

Introduction

Several factors have been shown to influence the amount of endogenous protein and amino acids (AA) recovered at the distal ileum in pigs (Sauer & de Lange, 1992). Dietary factors such as fiber, fat, and antinutritional factors have been shown to increase the amount of endogenous losses. It has also been suggested that the total amount of DM ingested by an animal (Butts et al., 1993b) and body weight (BW) of the animal (Mariscal-Landin et al., 1995) affect the extent to which endogenous proteins are secreted. If this is the case, it would appear that endogenous losses in sows would be significantly different from the values observed in growing pigs. The present experiment was conducted to test this hypothesis.

Materials and methods

Animals, housing, and diet. Ten growing barrows of 95 to 120 kg BW arising from the matings of Camborough 15 sows to PIC line 326 boars (PIC, Franklin, KY) and five sows (Camborough 15, PIC, Franklin, KY) were used in this experiment. All animals were

prepared with a simple T-cannula in the terminal ileum. Pigs were cannulated at approximately 36 (+/- 5) kg of body weight, and sows (Parity 3 to 6) were cannulated at day 40 (+/- 4) of gestation as described by Stein et al. (1997). Only four of the sows were used to calculate endogenous secretions in *ad libitum* fed gestating sows, whereas all five sows were used in restricted fed gestating sows and in lactating sows. All animals were housed individually throughout the trial in environmentally controlled buildings maintained at 20 to 22 °C. Pigs were housed in 0.9 by 1.8 m pens with slatted concrete floors, and gestating sows were housed in 5 by 5 m pens with partly slatted concrete floors. Lactating sows were kept in standard farrowing crates on a plastic coated expanded metal floor. During lactation, litter size was maintained at 9 or 10 piglets on all sows. The same corn starch based nitrogen (N) free diet was fed to all animals. 5 % sucrose, 5 % solka flock (a source of cellulose), and 4 % soybean oil was included in the diet. Vitamins and minerals were supplied to meet NRC requirements for lactating sows (NRC, 1988), and 0.25 % chromic oxide was included in the diet as an indigestible marker.

Feeding and digesta collection. During each collection period, the N free diet was fed to the animals for a 7 d period. The initial 5 d of each feeding period was considered an adaptation period, and digesta were collected for a 12 h period on each of the last 2 d of the feeding period. During collection of digesta, 225 ml plastic bags were attached to the cannulas and removed whenever they were filled with digesta or at least every 30 min. Pigs and lactating sows were collected once and gestating sows were collected twice. Growing pigs and lactating sows were fed *ad libitum*. Gestating sows were restricted to 2 kg of feed intake supplied in two equal meals in their first collection period, whereas they were allowed *ad libitum* access to feed during their second collection period. All animals had free access to water throughout the experiment. Following collection, digesta were frozen in the collection bags. At the end of each collection period, samples were thawed, pooled for each animal, and mixed, and a subsample was taken and frozen.

Sample analysis and calculations. At the end of the experiment, all subsamples were freeze dried, ground, and analyzed for DM and N (AOAC, 1990). The chromium content of the diet and digesta was determined by atomic absorption spectrophotometry (Williams et al., 1962). AA contents of samples were determined by an HPLC AA analyzer after hydrolysis with 6 N HCL under reflux at 110 °C for 24 hr. The sulfur containing AA were analyzed after oxidation with performic acid and subsequent hydrolysis with 6 N HCL. Tryptophan was determined by HPLC after alkaline hydrolysis using barium hydroxide at 125 °C for 16 h.

Endogenous secretions of AA and N were calculated (g/kg DM intake). Results were subjected to analysis of variance using the GLM procedure in SAS (SAS, 1995).

Results and discussion

All animals consumed (Kg/d) the diet very well, on average, 2.7 for growing pigs, 5.2 for lactating sows and 4.25 for *ad libitum* fed gestating sows. The flow of endogenous protein and AA at the terminal ileum is shown in Table 1.

The values obtained with growing pigs in this experiment are reasonably close to those previously reported in studies in which a protein free diet has been fed (i.g. Leterme et al., 1996; Butts et al., 1993a; Furuay & Kaji, 1989). Approximately 40 % of the AA secreted consisted of the 4 dispensable AA glutamate, proline, glycine and aspartate. Values obtained with *ad libitum* fed gestating sows were very close to those obtained with growing pigs. Endogenous secretions in lactating sows were slightly lower, but not significantly different (except for glycine, which was higher) from those obtained in growing pigs and *ad libitum* fed gestating sows ($P>0.05$). These observations would indicate that neither body weight

nor the physiological state of the animal affects the endogenous secretions of protein and AA if endogenous secretions are calculated proportionally to DM intake. Mariscal-Landin et al. (1995) suggested that endogenous output is related to BW rather than DM intake in growing pigs fed less than 70 g DM/kg$^{0.75}$BW. In the present experiment, growing pigs, lactating sows and one of the groups of gestating sows were allowed *ad libitum* access to feed and daily feed intake exceeded 70 g/kg$^{0.75}$BW for all three groups, which might explain why we obtained a different result.

Table 1. Endogenous secretions in growing pigs and sows, g/kg of dry matter intake.*

Group	Pigs	Lact. sows	Gestating sows		se.
			Restricted	Ad Libitum	
Protein	12.5^{b}	10.7^{b}	17.1^{a}	12.7^{b}	1.14
Total AA	10.2^{b}	8.3^{b}	15.1^{a}	11.6^{b}	1.22
Lysine	0.43^{ab}	0.34^{b}	0.53^{a}	0.47^{ab}	0.05
Methionine	0.12^{ab}	0.09^{b}	0.13^{a}	0.12^{ab}	0.014
Cysteine	0.24^{ab}	0.2^{b}	0.27^{a}	0.22^{ab}	0.022
Threonine	0.53	0.53	0.61	0.58	0.051
Tryptophan	0.15	0.15	0.16	0.15	0.015
Arginine	0.36^{b}	0.31^{b}	0.53^{a}	0.34^{b}	0.036
Phenylalanine	0.34	0.31	0.38	0.33	0.036
Tyrosine	0.30^{ab}	0.25^{b}	0.33^{a}	0.27^{ab}	0.032
Valine	0.49	0.39	0.54	0.49	0.058
Isoleucine	0.39	0.29	0.38	0.36	0.047
Leucine	0.59	0.52	0.65	0.57	0.064
Histidine	0.16^{b}	0.16^{b}	0.22^{a}	0.17^{b}	0.018
Glutamate	1.14^{ab}	0.87^{b}	1.28^{a}	1.08^{ab}	0.13
Proline	1.35^{b}	0.9^{b}	5.09^{a}	1.24^{b}	0.42
Glycine	0.73^{b}	1.18^{ac}	1.46^{a}	0.89^{bc}	0.12
Serine	0.45^{b}	0.44^{b}	0.65^{a}	0.52^{ab}	0.044
Alanine	0.59^{ab}	0.47^{b}	0.66^{a}	0.58^{ab}	0.065
Aspartate	0.88^{ab}	0.7^{b}	1.02^{a}	0.9^{ab}	0.1

* Values in the same row with different superscripts are significantly different ($p < 0.05$).

The restrictedly fed gestating sows had higher endogenous losses of all AA (/kg DM intake) than any of the other groups, and the values for protein, total AA, arginine, histidine, and proline were higher ($P<0.05$) than those obtained with the *ad libitum* fed animals. This finding indicates that feed intake *per se* has a significant effect on endogenous losses of AA in gestating sows. In growing pigs, Butts et al. (1993b) made a similar observation. Consequently, it is important to consider daily feed intake when values for endogenous secretions are compared between different experiments. In the restrictedly fed gestating sows, proline, glutamate, aspartate and glycine accounted for almost 60 % of the AA secreted which was considerably higher than in *ad libitum* fed animals. The loss of proline in restrictedly fed gestating sows was more than four times higher than in *ad libitum* fed gestating sows, and accounted for one third of total AA losses in these animals. Mariscal-Landin et al. (1995) suggested that the reason for the high proline loss is that the activity of pyrroline-5-carboxylate reductase (the enzyme that catalyses proline synthesis) is higher than that of the proline degrading enzyme, proline oxidase. Therefore, proline will accumulate in the enterocytes and diffuse back to the lumen. However, it is not clear why this mechanism is more pronounced in restrictedly fed gestating sows as compared to *ad libitum* fed gestating sows.

Conclusions

Endogenous secretions of protein and AA can be expressed proportionally to DM intake in *ad libitum* fed pigs and sows. Body weight and physiological state of the animals does not have a major impact on endogenous losses. However, daily feed intake affects the amount of endogenous losses, hence, it is important to consider the feeding level of the animals when comparing values for endogenous secretions between experiments. The results from this experiment suggest that values for endogenous secretions of AA and protein obtained in growing pigs can be applied to gestating as well as lactating sows as long as the feeding level is the same. Furthermore, when values for endogenous secretions are used to calculate true AA digestibilities, it is important that the animals used to calculate endogenous secretions are allowed the same feed intake as animals fed under normal production conditions.

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