4.2 Balance trial postweaning

Four different starter diets were investigated in four consecutive periods in this balance trial. In each period six weaned piglets were used. Unfortunately not all animals remained in experimental condition during the course of the trial. In period 1 (+AB) one pig removed its venous catheter with the effect that we were not able to collect blood and determine endogenous nitrogen losses and correct apparent ileal digestibility of nitrogen (AID_N) to real ileal digestibility (RID_N) in this animal. In period 2 one animal was put down due to illness (fever, no feed intake for several days) and a second pig hadn't had any feed intake during the digesta collection period and therefore wasn't appropriate for data analysis. Also in period 3 one piglet hadn't had any feed intake during digesta collection and therefore wasn't included in our data analysis. For period 4 we had just five animals in trial and one of these removed its blood catheter, so here as well we were not able to determine endogenous nitrogen losses and RID_N. Summarizing, we included data from six animals of period 1 (except for ENL, RID_N), four piglets of period 2, five of period 3 and five pigs of period 4 (except for ENL, RID_N). Data were summarized per period and are given as least square means ± standard error.

Body weight (BW) of animals at weaning (start of experiment) was 8.95 ± 0.26 kg, 9.10 ± 0.32 kg, 8.13 ± 0.28 and 7.64 ± 0.28 kg for the periods 1, 2, 3 and 4, respectively. Animals in period 4 had a significantly lower weaning weight than those in periods 1 and 2. At surgery animals weighed approximately 8.33 kg. The reason for the generally slight decrease in BW from weaning to surgery is most likely the change of feeding regime from sow milk (*ad libitum*) to starter diets (twice daily) and the adaptation to the new environment. All animals were healthy and in good condition at the time of surgery and, except for the subject mentioned above, remained in this condition during the entire trial. At trial end piglets had a BW of 11.60 ± 0.48 kg, 11.2 ± 0.58, 10.00 ± 0.52 and 7.1 ± 0.52 for the dietary regimes +AB, -AB, LF and HF, respectively. Piglets receiving diet HF had a significantly lower BW at the trial end compared to the other dietary regimes.

Due to the fact that animals differed in their body weight at the beginning of the experiment as well as in the end, parameters were related to metabolic body weight, enabling a more realistic comparison. DMI (g/kg BW $^{0.75}$) was 62.8 ± 5.7, 88.6 ± 7.0, 96.0 ± 6.3 and 104.8 ± 6.3 for diet period 1 (+AB), period 2 (-AB), period 3 (LF) and period 4 (HF), respectively. In period 1 (+AB) DMI was significantly lower than for the home-produced diets in periods 3 and 4. Closely correlated with DMI was the nitrogen intake (g/kg BW $^{0.75}$), which was 2.37 ± 0.21 for +AB, 3.36 ± 0.26 for –AB, 3.28 ± 0.23 for LF and for HF 3.94 ± 0.23. Here values for –AB and HF were significantly higher than for +AB.

Nitrogen content in ileal digesta (g/ kg BW $^{0.75}$) was determined and amounted to 0.53 ± 0.07, 0.70 ± 0.09, 0.41 ± 0.8 and 0.85 ± 0.08 for period 1, 2, 3 and 4, respectively. There was a significant lower N content at ileal level for diets +AB and LF compared to diet HF. Furthermore we determined intake and ileal content of total amino acids and single amino acids (annex9).

In the successive chapters we will always refer to **nitrogen** digestibility, losses et cetera instead of **crude protein** digestibility, loss. As **crude protein** - by definition - represents **nitrogen x 6.25** it appeared to us that this conversion is merely a matter of the respective convention. Also, nowadays in literature most results for protein digestibility and losses are reported in relation to nitrogen rather than crude protein, which make comparison easier this way.

Thus, having determined nitrogen and amino acid intake and content in digesta, we were able to calculate apparent ileal digestibility of nitrogen ($AID_{N/AA}$) and amino acids, respectively, using equation 5:

Equation 5. Calculation of apparent ileal digestibility of nitrogen and amino acids (%)

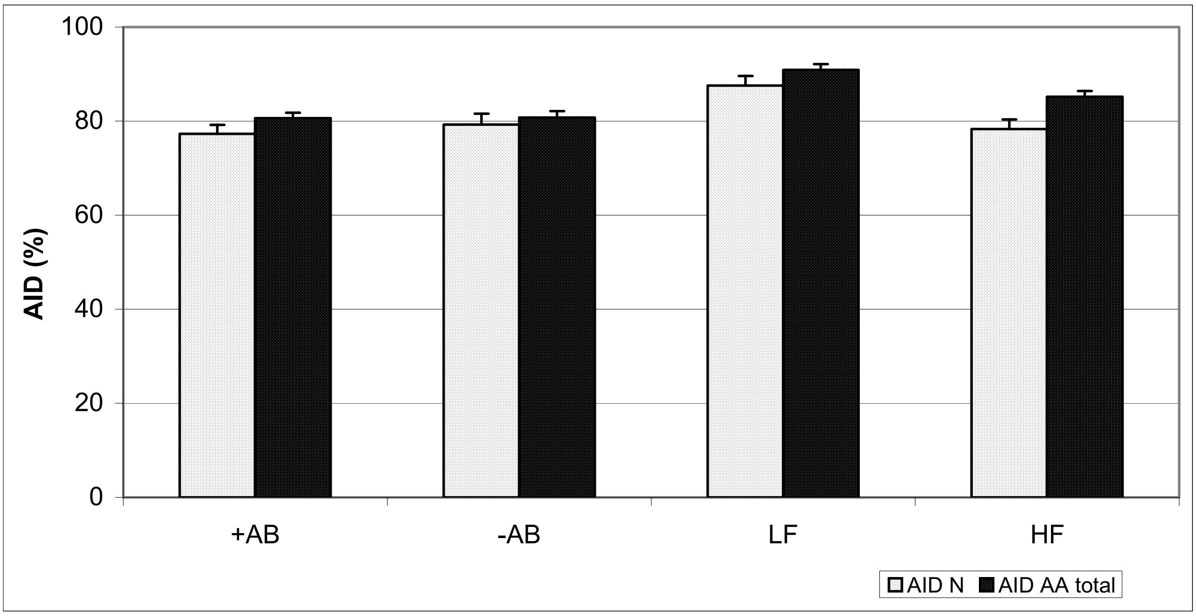
$$\frac{(N/AA_{intake}\ (g/d) - N/AA_{digesta}\ (g/d))*100}{N/AA_{intake}\ (g/d)}$$

N – nitrogen

AA – amino acids

Apparent ileal digestibility of nitrogen and total amino acids is depicted in Figure 27. AID_N (%) amounted to 77.30 ± 1.89 in period 1 (+AB), 79.24 ± 2.30 in period 2 (-AB), 87.54 ± 2.06 in period 3 (LF) and in period 4 (HF) to 78.28 ± 2.06. It is noteworthy that the AID_N of home-produced diet LF is approximately 10 % higher than in the other diets. So LF has a significant higher AID_N compared to diets +AB and HF. A similar picture was obtained for $AID_{AA\ total}$, with generally higher values for all diets: 80.64 ± 1.11 for +AB, 80.76 ± 1.36 for –AB, 90.86 ± 1.22 and for HF 85.16 ± 1.22 %. Here as well diet LF proofed to be significantly higher than all other starters.

Figure 27. Apparent ileal digestibility of nitrogen and amino acids (%) in piglets



Furthermore we estimated the daily ileal flow of DM and nitrogen. We calculated the flow in relation to metabolic body weight as well, to take the differences in body weight into account. As we did not see any difference between these two expressions, results are given as gram per day (Table 19). Piglets receiving the high fibre diet HF showed a general higher DM flow than for the other diets, but reached statistical significance for LF only. Nitrogen flow appears slightly different, with diet –AB being significantly higher than LF. Nitrogen flow for HF is similar to that of reference diets.

Table 19. Ileal flow of DM, total and endogenous nitrogen (g/d) in piglets fed four different diets

Ileal flow (g/d)	+AB	-AB	LF	HF
Dry matter	122.85 ± 13.25 [ab]	136.50 ± 14.81 [ab]	101.06 ± 13.25 [a]	155.24 ± 13.25 [b]
Total N	3.28 ± 0.35 [ab]	4.25 ± 0.39 [a]	2.27 ± 0.35 [b]	3.64 ± 0.35 [ab]
Endogenous N	1.79 ± 0.28	1.86 ± 0.31	2.00 ± 0.28	2.75 ± 0.31

Mean values with unlike superscripts in one line are significantly different ($P<0.05$)

Applying the ^{15}N tracer technique we were able to estimate endogenous nitrogen losses (ENL) at ileal level. ^{15}N-values in plasma (TCA-soluble fraction) were processed in a non-linear regression and individual graphs obtained for each piglet. Figure 28 is exemplary for a typical graph. By means of this regression we calculated the ^{15}N-excess in the TCA-soluble plasma fraction. Data were subsequently processed in equation 6 resulting in endogenous nitrogen (% of total nitrogen) in ileal digesta. Endogenous nitrogen (% of total nitrogen) at ileal level in piglets fed +AB, -AB, LF or HF accounted for 54.66 ± 6.98, 43.73 ± 7.81, 89.77 ± 6.98 and 73.08 ± 7.81, respectively. Both the reference diets showed lower endogenous nitrogen than the home-produced diets. Statistical analysis revealed that endogenous nitrogen for LF was significantly higher than for +AB and –AB.

Equation 6. Calculation of endogenous nitrogen (% of total nitrogen) at ileal level

$$\frac{\text{at \% } ^{15}\text{N-excess}_{\text{ileal digesta}} * 100}{\text{at \% } ^{15}\text{N-excess}_{\text{plasma}}}$$

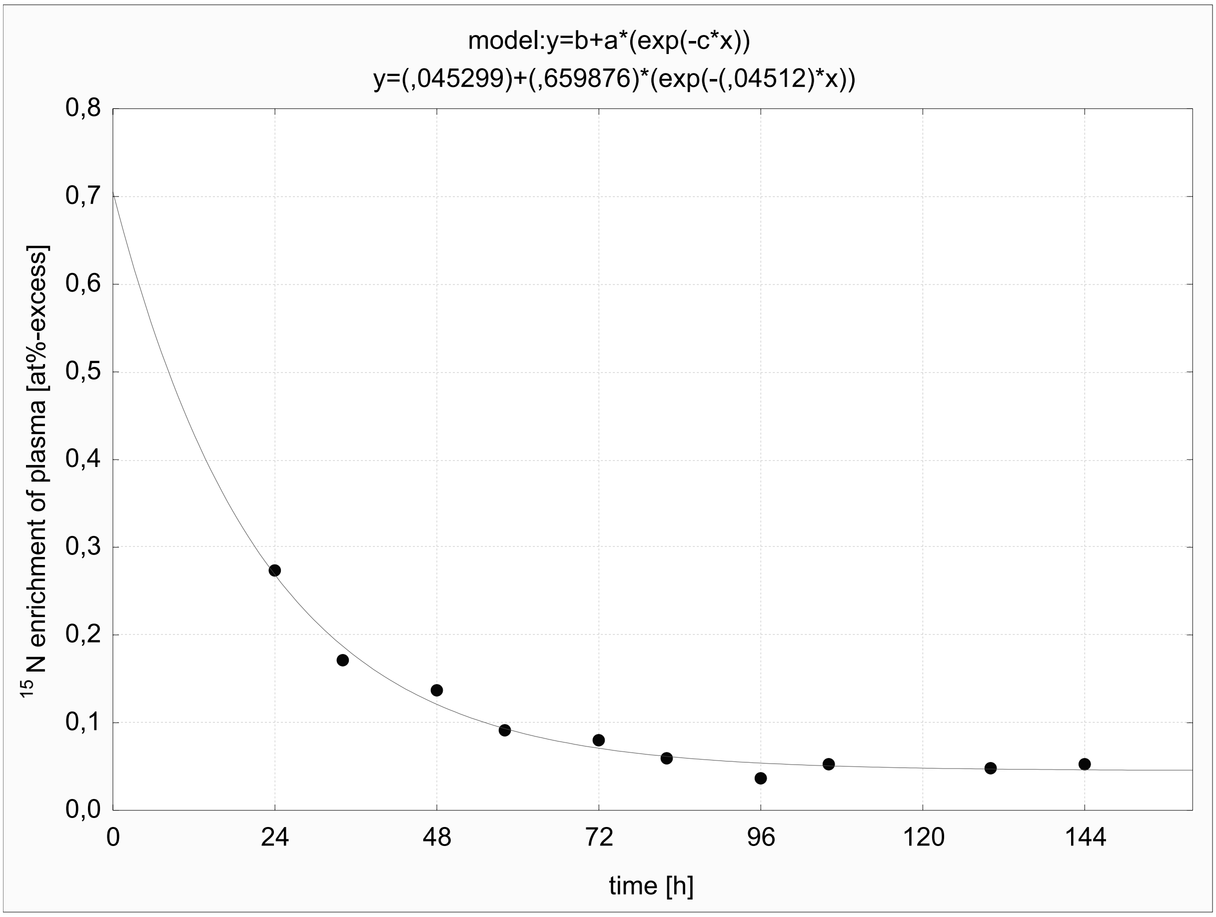
However, for reasons of comparability with literature on the topic of endogenous nitrogen in swine we expressed endogenous nitrogen per DM and protein intake, respectively (Table22). In this notation we didn't observe any statistical significance of endogenous nitrogen losses between the four dietary treatments.

Taking endogenous nitrogen into account enabled us to correct ileal nitrogen digestibility and calculate RID_N (equation 7). We refer to RID_N rather than to true ileal digestibility of nitrogen (TID_N) based on the following definitions (Darragh & Hodgkinson, 2000): RID_N incorporates the basal ENL independent of diet and the specific ENL depending on diet composition, especially on factors as fibre, protein and antinutritional factors (ANF). ENL can be estimated by means of ^{15}N-tracer technique or homoarginine method in animals receiving a diet with common protein sources such as cereals and legume seeds (Souffrant, 1991). TID_N takes basal ENL only into account, specific ENL are not covered. For the estimation of TID_N various methods can be employed: traditionally nitrogen-free diets were fed and the N at the terminal ileum was assumed to be the basal ENL. Other methods are to feed enzyme-hydrolyse protein or synthetic amino acids to the animals, thus supplying the animal with a protein source which is assumed to be 100 % digestible. Under this assumption nitrogen recovered at the terminal ileum is also supposedly basal ENL.

However, methods applied to estimate TID_N represent non-practical and even non-physiological (id. the protein-freed diet) conditions for the animals. The entire nitrogen metabolism of the animals is likely to be influenced by this and to respond. To obtain information about basal and specific ENL of practical diets with common protein sources, we employed the ^{15}N-tracer technique and subsequently estimated RID_N.

Basically RID_N showed lower values in piglets fed the two reference diets compared to those receiving home-produced diets, with RID_N (%) being 90.2 ± 1.3 (+AB), 88.3 ± 1.4 (-AB), 98.5 ± 1.3 (LF) and 94.0 ± 1.4 (HF). The difference between both the reference diets and LF reached statistical significance. To calculate RID of amino acids one need to determine endogenous amino acids by means of ^{15}N tracer technique. Due to technical difficulties we were not able to finish this up to this time, so unfortunately these data won't be presented in this thesis. Nevertheless we didn't abandon this aspect and analysis is still in progress, so presumably data will be presented in a different form.

Figure 28. ^{15}N-enrichment in plasma (TCA-soluble fraction) 4 days after oral labelling (animal 34)



Equation 7. Calculation of Real Ileal Digestibility (%) RID

$$\frac{(N/AA_{intake}\ (g/d) - N/AA_{digesta}\ (g/d) + N/AA_{endogenous}\ (g/d))*100}{N/AA_{intake}\ (g/d)}$$

N – nitrogen

AA – amino acids

Bacterial nitrogen was determined by means of the D-alanine method according to the specifications of Garrett et al. (1987). There was a marked difference in bacterial N contribution between the reference and home-produced diets. Bacterial N in ileal digesta of piglets receiving the reference diets amounted to 11.4 ± 0.7 and 11.8 ± 0.9 % of total N for +AB and –AB, respectively. Piglets fed home-produced diets had lower values, with 9.1 ± 0.8 for LF and 7.9 ± 0.8 % of total N for HF. Piglets fed HF had a significantly lower value than those receiving both reference diets. However, expressed as g/100 g CPI and g/100 g DMI, respectively, (Table 22) significances shifted from HF to LF.

Total ileal N is assumed to be 100 %, consisting of three components: exogenous (dietary) N, endogenous N and bacterial N. By subtraction of the determined endogenous and bacterial N from 100 % one obtains the third constituent: exogenous N. Thus we were able to estimate the constitution of total nitrogen in the terminal ileum of weaning piglets (Table 20).

Table 20. Constitution of total ileal N (%) in weaning piglets fed four different starters

	+AB	-AB	LF	HF
Endogenous N	54.66 ± 6.98 ^{a}	43.73 ± 7.81	89.77 ± 6.98 ^{b}	73.08 ± 7.81 ^{ab}
Bacterial N	11.39 ± 0.73 ^{a}	11.81 ± 0.90	9.06 ± 0.80 ^{ab}	7.94 ± 0.80 ^{b}
Exogenous N	34.12 ± 7.30 ^{a}	44.46 ± 8.16	1.17 ± 7.30 ^{b}	19.32 ± 8.16 ^{ab}

Mean values with unlike superscripts in one row are significantly different (P<0.05)