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# Effect of maternal feed intake during mid-gestation on pig performance and meat quality at slaughter

## Abstract
A study was conducted to evaluate, under commercial conditions, the effect of a high feed intake during mid-gestation on postnatal growth performance and meat quality of the progeny. Sows from 1 to 7 parities were divided into two treatments, control (C) and experimental (E). C sows received 3.0 kg/day (12 MJ of ME/kg) througout all gestation and E sows (E) received +50% and +75% extra feed from 45 to 85 days of gestation for first-parity and multiparous sows, respectively. This treatment (T) was applied thoughout two reproductive cycles (2 replicates; n=103 sows in replicate 1 and n=96 in replicate 2). The offspring (barrows) were divided in 5 weight groups (WG) and reared conventionally throughout nursery (n=958) and growing-finishing (n=636) periods. During the nursery period, E pigs exhibited higher growth rates (ADG) than C group (333 g/d *vs* 316 g/d, p<0.05) in replicate 1 and a higher feed efficiency (G:F) than C group (0.48 *vs* 0.47, p<0.05) in replicate 2. However, this differences disappeared in the growing-finishing period. The pigs of the lightest weight groups seemed to be the most benefited by the additional maternal feed allowance. At slaughter, E pigs in replicate 1 showed a higher carcass and ham weight. These pigs also showed a higher pH at 24 hours postmortem in the *semimembranosus* muscle and lower lightness values in the *longissimus* muscle than C pigs, and this fact was consistent in both replicates. Overall, increasing feed allowance from 45 to 85 days of gestation had slight effects on growth performance and lead to differences on meat quality traits at market weight.

Key Words: maternal feed intake, growth performance, meat quality

## Zusammenfassung
Titel der Arbeit: **Effekt der maternalen Futteraufnahme in der mittleren Trächtigkeit auf Leistung und Fleischqualität der Nachkommen beim Schwein**
Der Effekt einer erhöhten Futteraufnahme in der mittleren Trächtigkeit wurde unter kommerziellen Bedingungen untersucht. Die Sauen (1. bis 7. Trächtigkeit) wurden auf zwei Gruppen aufgeteilt: Kontrollgruppe (C), Versuchsgruppe (E). Die C-Sauen erhielten 3.0 kg/ Tag (12 MJ ME umsetzbare Energie)/kg) in der gesamten Trächtigkeit, und die E-Sauen erhielten +50% (1. Trächtigkeit) bzw. +75% (2. Trächtigkeit) extra Futter vom 45. bis zum 85. Trächtigkeitstag. Diese Behandlung erfolgte für die Dauer von zwei Reproduktionszyklen (n=103 in Wiederholung 1; n=96 in Wiederholung 2). Die Nachkommen (männliche Kastrate) wurden in 5 Gewichtsgruppen eingeteilt und während der Säugezeit (n=958) und Mast (n=636) konventionell aufgezogen. Während der Säugezeit zeigten die Schweine der Versuchsgruppe (E) höhere Wachstumsraten (ADG) als die der Kontrollgruppe (333 g/d vs 316 g/d, p<0.05) in Wiederholung 1 und eine bessere Futterverwertung (G:F) in Wiederholung 2 (0.48 vs 0.47, p<0.05). Diese Differenzen waren in der Mastperiode jedoch nicht mehr zu beobachten. Die Schweine der leichtesten Gewichtsgruppen schienen am meisten von der zusätzlichen maternalen Fütterung zu profitieren. Die Schlachtschweine der Versuchsgruppe hatten ein höheres Schlachtkörper- und Keulengewicht in der Wiederholung 1. Diese Gruppe zeigte auch in beiden Wiederholungen einen höheren pH Wert 24 h *post mortem* im *M. semimembranosus* und einen geringeren Helligkeitswert im *M. longissimus*. Insgesamt hatte die höhere verfügbare Futtermenge vom 45. bis zum 85. Tag der Trächtigkeit geringe Effekte auf die Wachstumsleistung und führte zu Unterschieden in der Fleischqualität.

Schlüsselwörter: Maternale Futteraufnahme, Wachstumsleistung, Fleischqualität

## Introduction
Maternal nutrition and other factors affecting the fetal environment (as hormonal treatments) may cause changes in postnatal growth (REHFELDT et al., 2004). In pigs, muscle mass is largely determined by the number of muscular fibers that, in turn, is positively correlated with postnatal growth (DWYER et al., 1993; GONDRET et al., 2005). Also, prenatal muscle fibre development is though to influence meat quality

(LARZUL et al., 1997), since contractile and metabolic properties of skeletal muscle may affect the pattern of energy metabolism in live animal, as well as during the post mortem conversion of muscle to meat (KARLSSON et al., 1999).

Myogenesis is a biphasic phenomenon with the sequential formation of two generations of muscle fibres. A primary generation forms from 25 to 50 days of gestation, followed by a second generation which form between 50 and 80 days of gestation (WIGMORE and STICKLAND, 1983). A possible positive effect was found on the number of muscle fibres when feed allowance during the first period of the myogenesis was increased (GATFORD et al., 2003). On the contrary, no effects or even opposite effects have been observed in other studies (NISSEN et al., 2003; BEE, 2004). However, this disadvantage overruled when the period of increased maternal feeding was prolonged from day 25 to day 70 of gestation (NISSEN et al., 2003), suggesting that increasing feed allowance during the period of the secondary fiber development may be more advantageous for the offspring. Thus, the present experiment was conducted to study, under commercial conditions, the implications of providing a higher feed intake to the sows during mid-gestation (from d 45 to d 85 of gestation) on growth performance and meat quality of the offspring.

## Materials and Methods

The experiment was conducted involving two reproductive cycles (2 replicates). LD x LW PIC sows from 1 to 7 parities were divided randomly into two treatments, Control (C, n=49 and n=46 in replicate 1 and 2, respectively) and Experimental (E , n=54 and 50 in replicate 1 and 2, respectively). C group received 3.0 kg/d (12 MJ of ME/kg feed and 6 g lysine/kg) throughout gestation (level routinely used on the farm) and E group received adiditionally + 50% and +75% of the control diet, for first-parity and multiparous sows, respectively, from d 45 to d 85 of gestation. After weaning, at 22 ± 2 days of age, piglets were reared conventionally throughout the nursery and the growing-finishing period.

Only barrows were used for the study of growth performance throughout the nursery (n=958) and the growing-finishing period (n=636). Pigs were divided into 5 weight groups (WG, being group 1 the heaviest and group 5 the lightest) per treatment and weighed weekly in the nursery and every three weeks in the growing-finishing phase. Feed consumption (ADFI) was also obtained in the nursery for all pens and in the growing-finishing period only for the middle and light WG. Carcass measurements [carcass weight, percentage of lean meat (Fat-O-Meat'er, SFK, Denmark), mid-line fat thickness at the gluteus medium (GM) and ham, *longissimus* (L) and *semimembranosus* (SM) muscle weight] and technological meat quality measurements [pH, drip loss and meat colour (Minolta CR300)] were registered in pigs from the lightests groups of weight (n=90), that were slaughtered at an average weight of 104.1±1.16 kg in replicate 1 and 120.9±2.65 kg in replicate 2.

Data was analysed using SAS (SAS Inst., Inc., Cary, NC, 2001). In all cases, gestation feeding level served as treatment and main factor. Statistical differences between treatments were analysed using the GLM procedure. In growth performance analysis, pen was the experimental unit and WG was added as a main factor and thus, interaction T*WG was also studied. In carcass and meat quality data analyses pig was the experimental unit. In all cases, the results are expressed as LS-means ± SE.

## Results

During the nursery period, E pigs showed higher ADFI and ADG in replicate 1 and a higher feed efficiency (G:F) in replicate 2 than C pigs (Table 1). These parameters were studied in detail within the nursery and the growing-finishing periods (data not shown) and it was observed that in both replicates, differences became statistically significant by days 53-58 of age. At this point, the interaction T*WG was significant for the lightests groups of pigs in test in replicate 1, being E pigs heavier than C. In spite of the differences found in the nursery period, these were not mantained during the growing-finishing period neither in replicate 1 nor in replicate 2 (Table 1).

Table 1
Nursery and growing-finishing growth performance (Wachstumleistung in der Aufzucht und Mast)

| **Replicate** | 1 | | | 2 | | |
|---|---|---|---|---|---|---|
| | **Maternal treatment[1]** | | | **Maternal treatment[1]** | | |
| **Growth period** | **C** | **E** | ***P-value*** | **C** | **E** | ***P-value*** |
| **Nursery [2]** | | | | | | |
| Pigs, No | 230 | 231 | - | 246 | 251 | - |
| ADFI, g/d | 430 ± 0.004 | 448 ± 0.004 | 0.008 | 455 ± 0.006 | 455 ± 0.006 | 0.962 |
| ADG, g/d | 316 ± 0.004 | 333 ± 0.004 | 0.013 | 327 ± 0.005 | 333 ± 0.005 | 0.316 |
| G:F | 0.73 ± 0.005 | 0.74 ± 0.005 | 0.322 | 0.72 ± 0.005 | 0.74 ± 0.005 | 0.038 |
| **Growing-Finishing[3]** | | | | | | |
| Pigs, No | 188 | 189 | - | 129 | 130 | - |
| ADFI, g/d | 1670 ± 0.041 | 1630 ± 0.041 | 0.518 | 1970 ± 0.038 | 2010 ± 0.038 | 0.491 |
| ADG, g/d | 789 ± 0.012 | 774 ± 0.012 | 0.390 | 808 ± 0.011 | 797 ± 0.011 | 0.442 |
| G:F | 0.47± 0.005 | 0.48 ± 0.005 | 0.627 | 0.40 ± 0.009 | 0.38 ± 0.009 | 0.164 |

[1] Maternal treatment, C: 3 kg/d and E: +50% or +75% amount of feed than C from 45 to 85 days of gestation,; [2] Nursery period: from 21 to 62 d on average; [3] Growing-Finishing period: from 62 to 184 d on average.

Table 2
Carcass and meat quality traits (Schlachtkörper- und Fleischqualitätsmerkmale)

| **Replicates** | 1 | | | 2 | | |
|---|---|---|---|---|---|---|
| | **Maternal treatment[1]** | | | **Maternal treatment[1]** | | |
| **Variable** | **C** | **E** | ***P-value*** | **C** | **E** | ***P-value*** |
| Pigs, No | 25 | 25 | - | 20 | 20 | - |
| Carcass wt (kg) | 72.4 ± 2.020 | 77.9 ± 1.978 | 0.056 | 87.43 ± 2.360 | 86.7 ± 2.360 | 0.835 |
| Lean meat (%) | 54.23 ± 0.738 | 52.68 ± 0.738 | 0.146 | 54.11 ± 0.920 | 53.35 ± 0.920 | 0.563 |
| GM[2] (mm) | 17.52 ± 1.018 | 19.24 ± 1.018 | 0.238 | 22.6 ± 1.033 | 21.65 ± 1.033 | 0.520 |
| $pH_{45}$[3] | | | | | | |
| SM[4] | 6.18 ± 0.047 | 6.22 ± 0.047 | 0.546 | 6.24 ± 0.048 | 6.14 ± 0.048 | 0.145 |
| L[5] | 6.17 ± 0.051 | 6.30 ± 0.051 | 0.079 | 6.19 ± 0.035 | 6.12 ± 0.035 | 0.124 |
| Main cuts weight (kg) | | | | | | |
| SM[4] | 0.972 ± 0.026 | 1.059 ± 0.028 | 0.030 | 1.177 ± 0.033 | 1.165 ± 0.033 | 0.720 |
| L[5] | 2.65 ± 0.111 | 2.67 ± 0.223 | 0.695 | 3.22 ± 0.099 | 3.21 ± 0.099 | 0.920 |
| Ham | 10.56 ± 0.265 | 11.38 ± 0.271 | 0.036 | 13.17 ± 0.324 | 13.27 ± 0.324 | 0.840 |
| $pH_{24}$[6] | | | | | | |
| SM[4] | 5.53 ± 0.027 | 5.62 ± 0.029 | 0.045 | 5.60 ± 0.031 | 5.71 ± 0.031 | 0.013 |
| L[5] | 5.53 ± 0.019 | 5.53 ± 0.019 | 0.918 | 5.59 ± 0.016 | 5.62 ± 0.016 | 0.175 |
| Meat colour[7] | | | | | | |
| L | 53.89 ± 0.567 | 52.38 ± 0.567 | 0.066 | 51.88 ± 0.755 | 49.39 ± 0.755 | 0.025 |
| a | 5.36 ± 0.242 | 5.43 ± 0.242 | 0.852 | 5.61 ± 0.213 | 6.13 ± 0.213 | 0.090 |
| b | 3.86 ± 0.271 | 4.32 ± 0.271 | 0.238 | 4.47 ± 0.227 | 3.98 ± 0.227 | 0.135 |
| Drip loss (%) | 1.84 ± 0.294 | 1.87 ± 0.294 | 0.939 | 0.87 ± 0.178 | 1.22 ± 0.178 | 0.171 |

[1] Maternal treatment, C: 3 kg/d and E: +50% or +75% amount of feed than C from 45 to 85 days of gestation,; [2] GM: Mid-line fat thickness at gluteus medium; [3] $pH_{45}$: pH at 45 minutes postmortem; [4] SM: *Semimembranosus* muscle; [5] L: *Longissimus* muscle; [6] $pH_{24}$: pH at 24 hours postmortem; [7] Meat colour (L: lightness; a: redness; b: yellowness) was measured in LD muscle.

Increased maternal feed intake during mid-gestation did not lead to differences on lean meat content, GM, $pH_{45}$ and drip loss measurements in the 90 selected pigs (Table 2). Regarding to the main cuts weight, in replicate 1, E pigs showed higher SM muscle and ham weights, according to the tendency to a higher carcass weight observed for this group. At 24 h post-mortem, $pH_{24}$ in the SM muscle was significantly higher and lightness in the L muscle tended to be lower in the E group compared to the C group, in both replicates.

## Discussion

Feed restriction during pregnancy has negative effects on the postnatal growth of the offspring (POND et al., 1985). However, the effects of feed supplementation during gestation are not so clear in the literature. Contradictory results have been obtained on muscle fiber development and postnatal growth (DWYER et al., 1994; GATFORD et al., 2003; NISSEN et al., 2003; BEE et al., 2004; HEYER et al., 2004). In the present experiment, the supplementation took place later than in most of the studies previously mentioned (from day 45 to 85 of gestation) and slight differences in growth performance and growth efficiency between treatments were observed at the near end of the nursery period (50 to 60 days of age). It has been shown that latter in the nursery phase, growth is more correlated to the number of muscle fibres (potential for growth) than to other factors such as birth weight (DWYER et at., 1993; GONDRET et al., 2005). When differences in growth performance appeared, the higher response was observed in the lightest WG, as it has been previously reported (DWYER et at., 1994; REHFELDT et al., 2001). For this reason, we select this range of weight for carcass and meat quality. Later, in the growing-finishing phase, the differences in growth performance disappeared. However, in replicate 1, we observed that the E pigs tended to show a higher carcass weight, suggesting that feed supplementation during mid-gestation could lead to a higher growth rates in the lightest groups of pigs, also during the growing-finishing phase.

On the other hand, low pH values have been related with an increased lightness and drip loss parameters (SCHAFER et al., 2002). In the present study, contrary to NISSEN et al. (2003) and HEYER et al. (2004), C pigs showed a lower $pH_{24}$ in the SM muscle and higher lightness values in the L muscle than E pigs, and these results were consistent between replicates. However, values of $pH_{24}$ and lightness in both treatments were within the normal for meat pork.

From our results we conclude that increasing feed allowance during the time of the secondary muscle development (from 45 to 85 days of gestation) has slight effects on growth performance. In addition, changes in meat quality parameters have been observed. Wether these differences are due to changes in muscle fiber characteristics is still unknown. Within the present work, further studies are being conducted to establish the effect of this feeding strategy on sow performance and muscle fiber development.

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