Effect of gestation feeding strategies on piglet average birth weight

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Abstract

When aiming for a low preweaning mortality, the average piglet birth weight plays an important role. Thus, the aim of this article is to summarise and consider dietary changes which potentially could increase average piglet birth weight. It is questionable whether an increased feeding level in late gestation can increase birth weight, and several studies with hyper-prolific sows failed to increase piglet birth weight. Likewise, increasing the dietary level and standardised ileal digestible (SID) lysine does not increase piglet birth weight. Placental growth may provide a potential for increased fetal growth, and thus, more research in mid-gestation is required, both in terms of daily feeding level and specific nutrients. Several nutrients may be beneficial in various parts of gestation, however, these results are not consistent. In order to maximise lactation performance, the feeding of gestating sows should aim to optimise backfat thickness at farrowing at 14-17 mm. In conclusion, bump-feeding in late gestation may not be the easy way to a higher birth weight. Instead, focus on having more uniform sows at the end of gestation increases the litter gain throughout lactation.

Keywords: Gestating sows, litter size, piglet birth weight, feeding level, body condition score

Introduction

In modern pig production, the focus on increasing litter size has increased the number of piglets weaned per sow per year drastically for the past decades. However, increasing litter size has led to a decrease in average piglet birth weight (Riddersholm et al., 2021; König et al., 2020; Smit et al., 2013; Quesnel et al., 2008). Preweaning mortality is partly dependent on piglet birth weight (Rutherford et al., 2013; Langendijk et al., 2023), and as litter size increases and birth weight decreases, a higher proportion of piglets with signs of moderate and severe intrauterine growth restriction (IUGR) is observed (Riddersholm et al., 2021), which has led to an increased preweaning mortality (Hansen et al., 2019). Piglet birth weight is also dependent on sow parity (Quesnel et al., 2008), but may also be affected by sow feeding strategy during gestation. As the requirement of the sow changes throughout gestation due to the growth of the placenta, fetuses and udder, three sub-periods of either early gestation (day 0-28), mid gestation (day 28-84) and late gestation, covering from around day 84 and until farrowing, are often considered (De Vos et al., 2014). Thus, the aim of this article is to summarise and consider dietary changes which potentially could increase average piglet birth weight.

Questionable whether feeding level in late gestation affects piglet birth weight

Fetal growth occurs mainly from day 84 to parturition, and over time this period has been in particular focus when trying to increase piglet birth weight. Several studies have focussed on increasing the average daily feeding level for 14-28 days before farrowing, but failed in increasing average piglet birth weight (Shelton et al., 2009; Greiner et al., 2016; Langendijk et al., 2023; Mallmann et al., 2018; Sørensen and Krogsdahl, 2018). Eventhough most fetal growth occurs within the last three to four weeks before farrowing, dietary interventions during this period seem to be too late. In a Danish study conducted by Sørensen (2012), it was demonstrated that increasing the feeding level, and thus, also daily supply of lysine and protein, from 2.3 to 3.3 kg/day, increased average piglet birth weight by 30 g. Whereas a further increase by 1 kg feed only led to a further 10 g increase in average piglet birth weight (Table 1). These fairly small changes in average piglet birth weight will not have major impact on preweaning mortality. In a large-scale follow-up study, Sørensen & Krogsdahl (2018) found no effect of increasing the daily feeding level with around 0.5 kg per day (+14%) and, at the same time, increasing the level of SID (+60%) and SID protein (+13%). Feeding the improved diet did not affect average piglet birth weight in sows with around 21 total born piglets per litter, as can be seen in Table 2.

Table 1 – Effect of increasing the daily feeding level the last four weeks before farrowing in multiparous sows giving birth to around 18 total born piglets per litter on average piglet birth weight (Sørensen, 2012).

Feeding level, kg per day	2.3	3.3	4.3
Litters, no.	379	374	385
Total born piglets per litter, no.	17.9	18.0	18.0
Average piglet birth weight, kg	1.31[a]	1.34[b]	1.35[b]
Piglet survival day 0-7, %	90.2	90.0	89.9

[ab]Within a row, values without common superscript letters, differ (P < 0.05).

Table 2 – Effect of increasing the daily feeding level with 0.5 kg and simultaneously increasing the daily lysine intake by 60% for the last four weeks before farrowing in sows giving birth to around 21 total born piglets per litter on average piglet birth weight (Sørensen and Krogsdahl, 2018).

Feeding level, kg per day	3.5	4.0
Litters, no.	199	206
Total born piglets per litter, no.	21.0	20.8
Live born piglets per litter, no.	18.9	18.8
Average piglet birth weight, kg	1.31[a]	1.31[a]
Piglet survival day 0-7, %	89.6	89.6

[ab]Within a row, values without common superscript letters, differ (P < 0.05).

These results raise the question whether bump-feeding in late gestation is the optimal solution to possibly increase average piglet birth weight.

More lysine does not per se increase piglet birth weight

It is often stated that increasing the lysine and, hence, protein concentration in the gestation feed will lead to increased birth weight. However, Rehfeldt et al. (2011) showed that neither undersupplying nor oversupplying gestating sows with protein resulted in a significantly lower average piglet birth weight. More recently, a large-scale Danish dose-response trial - with standardised ileal digestible lysine levels ranging from around 3.0 to 6.0 g/kg feed at a fixed feeding curve throughout gestation – did not show any linear effect on birth weight, and no threshold for dietary lysine concentration that could optimise piglet birth weight (Bruun et al., unpublished).

Using feed additives in different periods or throughout gestation to affect piglet birth weight

Feed additives like L-carnitine have the potential to affect birth weight, however, as reviewed by Ringseis et al. (2018), the results are not consistent. The amino acid arginine is of great importance during placental development as it affects angiogenesis and vascular development, also has the potential to increase average piglet birth weight (Nuntapaitoon et al., 2018; da Silva Fonseca et al., 2022). However, other studies identify no positive effects on piglet birth weight when feeding increased levels of dietary arginine for gestating sows (Moreira et al., 2020). As reviewed by Strathe and Bruun (unpublished), several Danish trials using specific nutrients, such as a low dosage of docosahexaenoic acid (omega-3 fatty acid), or using a partly replacement of inorganic zinc, copper, and manganese with organic counterparts of either of the two sources failed to influence piglet birth weight as well as proportions of piglets weighing below 800 g and 1000 g. If an effect of omega-3 fatty acids should be observed, it will most likely require higher amounts of omega-3 fatty acids, in terms g/kg rather than mg/kg (Bruun et al., 2022). When looking at the total feed costs of feeding gestating sows, inconsistent research results should be considered before adding a variety of feed additives.

More focus on placental growth in mid-gestation is required

Altogether, these results could be an indication that specific nutrients are probably not the limiting factor for piglet birth weight. As suggested by Langendijk et al. (2023), feeding sows in mid-gestation may be of particular interest, as this is the time frame when placentas are growing (Noblet et al., 1985; 1997). There is a strong correlation between placental size and piglet birth weight (König et al., 2020; Langendijk et al., 2023), which has also been identified in hyper-prolific DanBred Hybrid sows (Lyderik et al., 2023). A new trial by

SEGES Innovation will focus on applied feeding of sows in mid-gestation to uncover possible positive effects on piglet birth weight, however, results should not be expected before October 2024.

Practical considerations and recommendations

Optimising the lactational performance of hyper-prolific sows requires focus on sow body condition (Kim et al., 2015; Kim et al., 2016). Backfat measurements (Figure 1) are easy to perform after a little practice, and it can be the key to more uniform sows and to reach the optimal backfat level at farrowing. Based on a Danish study with more than 3900 lactation periods, it is recommended to aim for at backfat thickness (P2) of 14-17 mm at farrowing to maximise the nursing capacity of the sow, and hence, average daily litter gain.

Systematic backfat measurements include measuring backfat at weaning, at around 28 days of gestation, at around 70-80 days of gestation (optional), and at farrowing. The latter is the evaluation of the job done throughout gestation – are the feeding curves resulting in the optimal body condition score or should changes be implemented? Please keep in mind, that to increase the average backfat level by 1 mm requires at least 20 kg of feed above maintenance level, and that using low protein diets makes the sow gain less muscle mass when striving for the optimal backfat level.

Figure 1 – Backfat measurement is a key routine to get uniform sows. Based on backfat measurements alterations in the daily feeding level can be implemented to reach 14-17 mm of backfat at farrowing. Photo: Rasmus Bendix, Bendix Production.

Conclusion

Choosing certain dietary feed additives throughout gestation does not seem to be an easy way to improve average piglet birth weight. At the same time, bump-feeding in late gestation is also questionable. However, more research in the applied feeding of hyper-prolific gestating sows may be required, especially considering feeding levels and factors that may influence placental growth in mid gestation. From a practical point of view, achieving uniform sows with 14-17 mm of backfat at farrowing seems to be a precondition for success in the farrowing unit. Achieving uniform sows may further alleviate problems with sows that are under supplied throughout gestation, which can possibly affect average piglet birth weight.

References

Bruun, T. S., Bache, J. K., Jensen, S. K. and Strathe, A. V. 2022. Adding a low dose of omega-3 fatty acids of algae origin to sow feed did not affect piglet birth weight or average daily litter gain [In Danish: Tilsætning af lav dosis omega-3 fedtsyrer fra alger til sofoder påvirkede ikke fødselsvægt og daglig kuldtilvækst]. Publication no. 1261, SEGES Innovation. Retrieved on 26 April 2023 from https://www.landbrugsinfo.dk/public/f/0/e/management_tilsatning_omega_tre_fedtsyrer_pavirkning_fodselsvagt

da Silva Fonseca, L., Lanferdini, E., Herculano, R., Moreira, R., Chaves, R. F., Perazolli, P. H., de Paula, Y. H., Rennó, L. N., Garbossa, C. A. P., de Souza Cantarelli, V. and de Abreu, M. L. T. 2022. Arginine supplementation in the feed of gestating sows. Livestock Science, 263, 104999.

De Vos, N., Che, L., Huygelen, V., Willemen, S., Michiels, J., Van Cruchten, S. and Van Ginneken, C. 2014. Nutritional interventions to prevent and rear low-birth weight piglets. Journal of Animal Physiology and Animal Nutrition, 98, 609-619.

Greiner, L., Graham, A., Touchette, K. J. and Neill, C. R. 2016. The evaluation of increasing lysine or feed amounts in late gestation on piglet birth weights. Journal of Animal Science, 94, 123-124.

Hansen, C. F., Hales, J., Amdi, C. and Moustsen, V. A. 2019. Intrauterine growth-restricted piglets defined by their head shape have impaired survival and growth during the suckling period. Animal Production Science, 59, 1056-1062.

Højgaard, C. K. and Bruun, T. S. 2021. Background for changing the recommended sow backfat thickness arund farrowing [In Danish: Baggrund for ændring af anbefalet rygspæktykkelse hos søer omkring faring]. Publication no. 2130, SEGES Danish Pig Research Centre. Retrieved on 17 April 2023 from https://svineproduktion.dk/publikationer/kilder/notater/2021/2130

Kim, J. S., Yang, X., Pangeni, D. and Baidoo, S. K. 2015. Relationship between backfat thickness of sows during late gestation and reproductive efficiency at different parities. Acta Agriculturae Scandinavica, Section A — Animal Science, 65, 1-8.

Kim, K. H., Hosseindoust, A., Ingale, S. L., Lee, S. H., Noh, H. S., Choi, Y. H., Jeon, S. M., Kim, Y. H. and Chae, B. J. 2016. Effects of Gestational Housing on Reproductive Performance and Behavior of Sows with Different Backfat Thickness. Asian-Australasian Journal of Animal Science, 29, 142-148.

König, N. L., Wähner, M., Seeger, J., Sigmarsson, H. L. and Kauffold, J. 2020. An investigation into uterine capacity based on litter and placental characteristics in two sow lines with different prolificacy (Danish Landrace x Danish Yorkshire versus German Saddleback). Reproduction in Domestic Animals, 56, 34-45.

Langendijk, P., Fleuren, M. and Page, G. 2023. Review: Targeted nutrition in gestating sows: opportunities to enhance sow performance and piglet vitality. Animal, 100756.

Lyderik, K. K., Østrup, E., Bruun, T. S., Amdi, C. and Strathe, A. V. 2023. Fetal and placental development in early gestation of hyper-prolific sows. Theriogenology, 197, 259-266.

Mallmann, A. L., Betiolo, F. B., Camilloti, E., Mellagi, A. P. G., Ulguim, R. R., Wentz, I., Bernardi, M. L., Gonçalves, M. A. D., Kummer, R. and Bortolozzo, F. P. 2018. Two different feeding levels during late gestation in gilts and sows under commercial conditions: impact on piglet birth weight and female reproductive performance. Journal of Animal Science. 96: 4209-4219.

Moreira, R. H. R., dos Santos Alves Mendes, M. F., Palencia, J. Y. P., Lemes, M. A. G., Roque, A. R., Kutschenko, M., Ferreira, R. A. and de Abreu, M. L. T. 2020. L-arginine supplementation during the final third of gestation improves litter uniformity and physical characteristics of neonatal piglet thermoregulation. Journal of Animal Physiology and Animal Nutrition, 104, 245-656.

Noblet, J., Close, W. H., Heavens, R. P. 1985. Studies on the energy metabolism of the pregnant sow. I. Uterus and mammary tissue development. British Journal of Nutrition, 53, 251-265.

Noblet, J., Dourmad, J. Y., Etienne, M. and Le Dividich, J. 1997. Energy metabolism in pregnant sows and newborn pigs. Journal of Animal Science, 75, 2708-2714.

Nuntapaitoon, M, Muns, R., Theil, P. K. and Tummaruk, P. 2018.L-arginine supplementation in sow diet during late gestation decrease stillborn piglet, increase piglet birth weight and increase immunoglobulin G concentration in colostrum. Theriogenology, 121, 27-34.

Rehfeldt, C., Lang, I. S., Görs, S., Hennig, U., Kalbe, C., Stabenow, B., Brüssow, K.-P., Pfuhl, R., Bellmann, O., Nürnberg, G., Otten, W. and Metges, C. C. 2011. Limited and excess dietary protein during gestation affects growth and compositional traits in gilts and impairs offspring fetal growth. Journal of Animal Science, 89, 329-341.

Riddersholm, K. V., Bahnsen, I., Bruun, T. S., de Knegt, L. V. and Amdi, C. 2021. Identifying Risk Factors for Low Piglet Birth Weight, High Within-Litter Variation and Occurrence of Intrauterine Growth-Restricted Piglets in Hyperprolific Sows. Animals, 11, 2731.

Ringseis, R., Keller, J. and Eder, K. 2018. Basic mechanisms of the regulation of L-carnitine status in monogastrics and efficacy of L-carnitine as a feed additive in pigs and poultry. Journal of Animal Physiology and Animal Nutrition, 12959, 1-34.

Rutherford, K. M. D., Baxter, E. M., D'Eath, R. B., Turner, S. P., Arnott, G., Roehe, R., Ask, B., Sandøe, P., Moustsen, V. A., Thorup, F., Edwards, S. A., Berg, P. and Lawrence, A. B. 2013. The welfare implications of large litter size in the domestic pig I: biological factors. Animal Welfare, 22, 199-218.

Shelton, N. W., DeRouchey, J. M., Neill, C. R., Tokach, M. D., Dritz, S. S., Goodband, R. D. and Nelssen, J. L., 2009. Effects on increasing feeding level during late gestation on sow and litter performance. Proceedings of the Kansas Swine Day. Kansas state University, Manhattan, pp. 38– 50.

Smit, M. N., Spencer, J. D., Almeida, F. R. C. L., Patterson, J. L., Chiarini-Garcia, H., Dyck, M. K. and Foxcroft, G. R. 2013. Consequences of a low litter birth weight phenotype for postnatal lean growth performance and neonatal testicular morphology in the pig. Animal, 7, 1681-1689.

Sørensen, G. 2012. Extra feed for gestation sows four weeks prior to farrowing [In Danish: Ekstra foder til drægtige søer i fire uger før faring]. Publication no. 956, Danish Pig Research Centre. Retrieved on 24 April 2023 from https://svineproduktion.dk/Publikationer/Kilder/lu_medd/2012/956.aspx

Sørensen, G. and Krogsdahl, J. 2018. Extra feed, fibers and protein did not increase birth weight or preweaning piglet mortality [In Danish: Ekstra foder, fibre og protein øgede ikke fødselsvægten eller pattegriseoverlevelsen]. Publication no. 1158, SEGES Danish Pig Research Centre. Retrieved on 24 April 2023 from https://svineproduktion.dk/publikationer/kilder/lu_medd/2018/1158

Quesnel, H., Brossard, L., Valancogne, A. and Quiniou, N. 2008. Influence of some sow characteristics on within-litter variation of piglet birth weight. Animal, 2, 1842-1849.