Immune and metabolic regulation for improved sow performance

Optimal health and welfare of the sow before farrowing provides the best potential for a successful farrowing and lactation performance. However, sometimes sows do not perform as expected during this key period, with a lack of energy during farrowing and poor milk production during lactation noted as key factors.

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The inefficient conversion of feed to metabolic energy and milk production is associated with disturbed glucose metabolism. Increasing sow productivity starts with the birth of vigorous piglets. This vigour is influenced by sufficient nutrition in the uterus and on a smooth birthing process.

The longer the birthing process takes, the higher the chances become for increases in stillbirths and hypoxia in the piglets due to higher likelihood of the umbilical cord being damaged.

With an increase in the number of piglets born alive per litter, the farrowing process requires more energy over a longer duration. During farrowing more energy is required to maintain the number of contractions and contraction strength. Therefore an adequate glucose distribution towards the uterus and its uptake by uterine muscle cells helps to reduce the farrowing time and thus reduce piglet mortality.

Glucose metabolism and energy

Glucose absorbed from the digestive tract into the portal vein is the primary source of energy in swine. From the liver, glucose is either stored (as glycogen, or triglyceride) or redistributed to all parts of the body to serve as an energy source but may also be stored as glycogen in skeletal muscle tissue for future requirements.

However, a disruption in this distribution occurs naturally during the third trimester of gestation and is caused by increased insulin resistance. Insulin is needed to transfer glucose from the blood into the cells. During this naturally occurring insulin resistance in the third trimester of pregnancy, blood glucose levels stay higher.

This ensures there is enough glucose in circulation for growth of the foetuses in utero, for the uterine muscles during farrowing and for the mammary gland for milk production. The growth rate of foetuses has a larger impact on this insulin resistance of the dam than the number of foetuses present.

Disruption in glucose metabolism by insulin resistance becomes problematic in a cohort of sows who are genetically predisposed (approximately 30%) to develop resistance, resulting in high blood glucose levels and subsequently metabolic syndrome.

Measuring fasting (fasting for 12-16 hours) blood glucose levels can indicate the severity of insulin resistance, other parameters such as insulin levels, non-esterified fatty acid levels and calculation of HOMA-IR can also be used to quantify the level of insulin resistance.

A normal fasting blood glucose level for sows has been reported to range from 2.0-3.6mmol/L, while levels above this indicate that there is impaired glucose metabolism.

Multiple on-farm screenings agreed with the scientific literature, indicating insulin resistance in approximately 30% of the sows from high-performing Irish herds.

Insulin resistance has consequences for both sow and piglet health. The reduced glucose delivery to the piglets leads to issues with very small piglets (intra-uterine growth restriction) as well as, disturbance in the glucose delivery to the uterine muscles results in a long farrowing process, and subsequent high stillbirth levels.

The impact of insulin resistance on sow productivity has not been well investigated to-date. However, in human medicine it is part of mainstream clinical management of pregnancy to screen for gestational diabetes and treat the condition in order to deliver a healthy baby without complications.

The interaction between genetics, diet and environment are all known to have a roll in the incidence of insulin intolerance during gestation, type II diabetes and metabolic syndrome cohorts.

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Fig. 1. Number of piglets born alive per litter.

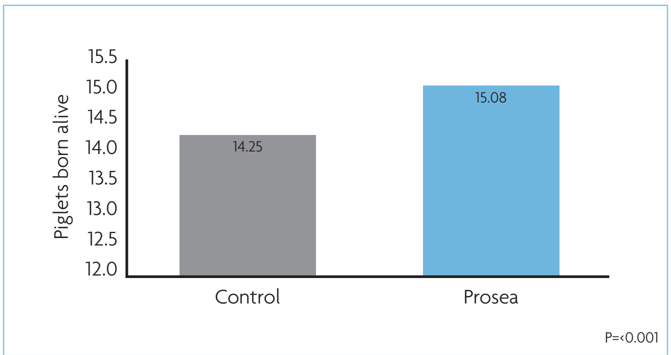
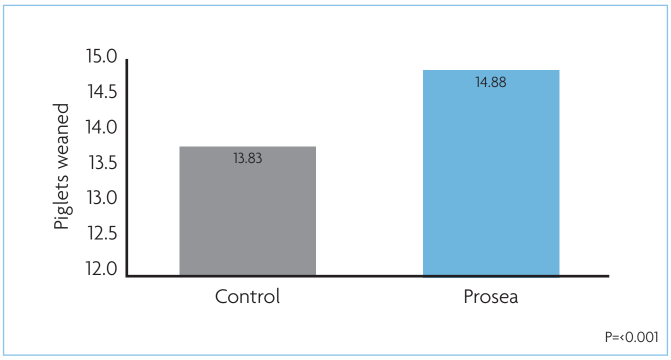


Fig. 2. Number of piglets weaned per litter.



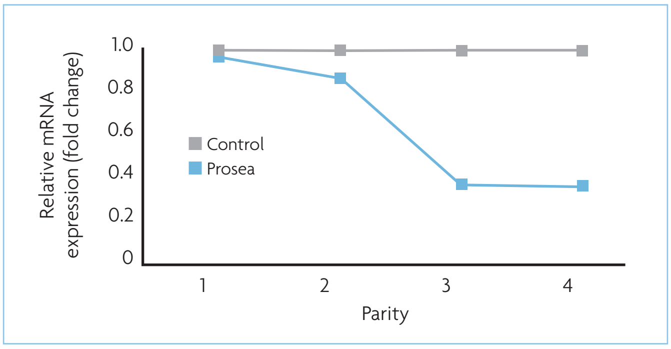


Fig. 3. Gene expression of the insulin resistance marker in umbilical cord tissue.

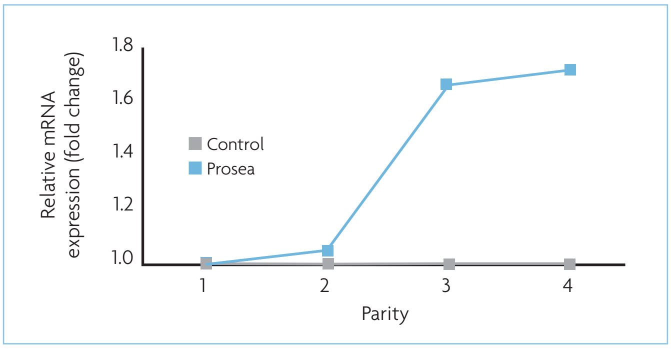


Fig. 4. Relative gene expression of the glucose transport SCL2A2 in umbilical cord tissue.

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Natural solutions to support sow health and welfare

Celtic Sea Minerals has specialist expertise in harvesting, processing and application of seaweed and natural marine phytonutrients. This has led to the development of a unique seaweed formulation known as Prosea that has immune modulating bio-actives and marine minerals that improves sow herd health and performance.

Prosea consists of two components, a calcified red algae and a proprietary processed extract from a brown algae. A strong synergy between these two components has been observed which delivers benefits to both the sow and her offspring. A triple mode of action explains the benefits:

- Optimising immune regulation.
- Improve glucose metabolism.
- Improve muscle functioning.

The optimised immune regulation modulates the immune system of both the dam as well as her offspring by increasing the immunoglobulin concentrations in colostrum. This will help the piglets to better develop their immune system and subsequently better withstand challenges post-weaning.

Regulation of the mucosal immune system in the digestive tract allows a stronger gut barrier to be developed, helping to reduce pathogenic transmission from the gut lumen to the bloodstream. This subsequently results in a reduction in systemic inflammation and the flaring of auto-immunity associated with insulin resistance and oxidative stress due to high circulating blood glucose levels.

An improved glucose metabolism is achieved by reducing the inflammation associated with insulin resistance experienced in late gestation, thereby improving distribution and uptake of glucose by the placenta, uterine muscles and the mammary gland after parturition.

This will support sow health and performance by enhancing piglet growth both pre- and postnatal. Improved glucose distribution subsequently enhances the energy available for the muscles, and therefore reducing farrowing time and placenta expulsion time.

This will improve piglet vitality and improve the number of piglets born alive and weaned.

Demonstration of optimised sow health and performance

The triple mode of action described above gives sows and their offspring the best opportunities for optimal performance. A 4-parity study performed using Prosea has shown remarkable results on sow performance. The results from this indicate that inclusion of Prosea in the gestation and lactation diet of sows enhances sow health and performance.

Prosea inclusion resulted in an increase of 0.7 piglets born alive compared to the control group (Fig. 1) and one piglet extra weaned per sow per litter (Fig. 2). These results are supported by a further meta-analysis performed over multiple studies.

Over eight studies, Prosea resulted in an increase in PWSY of 1.6. Not only did the number of pigs weaned increase, but the piglet body weight was also increased with 0.35kg per piglet. Together with the extra piglet weaned per sow per litter, this leads to an increase of 12kg in litter weight.

Parameters to quantify inflammation and insulin resistance and glucose transport were also measured. Cortisol, a pro-inflammatory metabolite, was significantly reduced both before and after farrowing, while adrenaline and noradrenaline were also reduced.

The marker for insulin resistance was reduced up to 2.5 fold, especially older parity sows in the umbilical cord, while the glucose transport in the umbilical cord was increased 1.8 fold when sows were fed Prosea. In certain parts of the world, the occurrence of pelvic organ prolapses (POP) is a significant problem and leads to reduced health and increased mortality in sows and subsequent losses for the producer. Loss of pelvic muscle tone has been associated with increased insulin resistance in humans and it is likely that this also occurs in sows.

Hence, the pelvic muscles that need to keep these organs in place have lost some of their strength and it is easier for the pelvic organs to become displaced. An initial, unpublished study has shown promising results in reducing the incidence of POP in sows when Prosea was fed.

Further studies are underway to investigate the relationship between insulin resistance and POP and the potential for Prosea to reduce this and improve sow health.

Conclusion

In order to maintain sow health and improve piglet vitality, improving energy distribution in the dam shows promising results. Prosea, a unique seaweed formulation with immune modulating bio-actives and marine minerals, has shown great potential in enhancing energy distribution in the dam and subsequently increasing the number of piglets born alive and number of piglets weaned. ■

References are available from the author on request