Organic selenium for hyperprolific sows

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Breeding, managing and feeding sows to produce more viable piglets per litter is a key current objective of pig producers. The hunt is on for the perfect 'hyperprolific' sow.

Crossing occidental and Chinese breeds yields higher litter sizes due to improved embryo survival, but meat quality of progeny is poor. Another approach centres on selection for larger litters in Western breeds.

The result is increased ovulation, perhaps four or five more per oestrus, but lower embryonic survival. Nevertheless, over the last decade litter sizes have increased by around 1-2 piglets/litter.

Table 1 illustrates the hyperprolificacy dilemma. Multiparous sows exhibit increased ovulation rates in comparison with gilts, but lower embryonic survival (72% versus 80%). Western breeds selected for hyperprolificacy ovulate more eggs at oestrus but embryonic survival is only 63%, in comparison with Chinese crosses where embryonic survival is 80%.

Canadian researchers are investigating factors around breeding and early pregnancy to enable the use of Western breeds in programmes to improve litter size and homogeneity. Western strains are preferred to Chinese hyperprolific sows due to meat and carcase quality of progeny.

Values estimated from data collected since 1995	Western gilts	Western sows	Western sows selected as hyperprolific	Chinese Cross sows (50% Meish)
No. eggs ovulated at oestrus	15	18	24	20
Viable embryos (day 25 of pregnancy)	12	13	15	16
Embryonic survival (%)	80	72	63	80

Table 1. The hyperprolifacy dilemma – Chinese crosses are prolific but progeny exhibit poor meat and carcase quality.

Canadian work suggests that supplementing sow diets with organic selenium (Se) supports embryo development in early gestation.

Such an effect could make a significant contribution to prolificacy in occidental breeds such as Landrace, Large White and Duroc, and if proven successful in the field, would enable the use of such breeds in prolificacy programmes, without sacrificing meat quality in progeny.

Increased ovulation rate in sows is linked to poor embryo survival. Professor Jacques Matte and colleagues at the Canadian Laval University and Swine Research and Development Centre, Agriculture and Agri-Food Canada postulated that progressive oxidative stress around successive oestrus, mating and breeding cycles is the cause, provoking poor quality ovulation and embryos, and so restricting the potential for sows to farrow larger, healthy and homogeneous litters.

Se in organic forms is known to be an effective anti-oxidant, but inorganic Se, which has pro-oxidant activity, is the common form used in feed supplements.

The Canadian studies, therefore, compared both sources of Se in a model using Western hybrids, with particular emphasis on embryonic parameters and anti-oxidant status in early pregnancy.

One important advantage of organic Se over inorganic Se is that it forms a reserve pool of Se, as selenomethionine, in body tissues.

For example, red blood cells store 50% of circulating Se, so gilts supplemented with organic Se from Se yeast exhibited significantly higher whole blood Se than controls or gilts supplemented with inorganic Se (Fig. 1). However, inorganic Se from selenite produced higher blood glutathione peroxidase (Se-GSH-PX), a Se-containing enzyme important in anti-oxidant defence systems (Fig. 2).

The researchers simulated hyperprolificacy in their experimental model by hormonal

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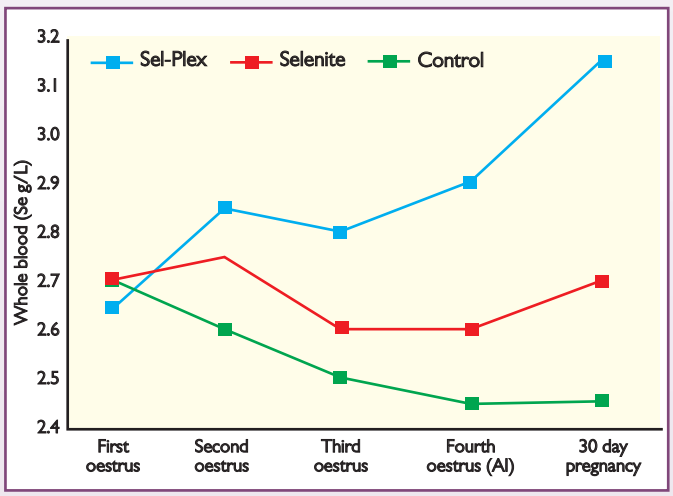
Fig. 1. Blood selenium status of gilts.



Mean values	Control (endogenous organic Se, 0.2ppm)	Selenite (control diet + 0.3ppm Se from selenite)	Sel-Plex (control + 0.3ppm organic Se from Se yeast)
No. embryos	14.3	14.3	15.2
Embryo weight (g)	1.36	1.31[a]	1.46[b]
Embryo length (mm)	20.5	20.1[a]	21.2[b]
Protein/embryo (mg)	57.5	55.7[a]	62.2[b]
DNA/embryo (mg)	1.57	1.56[a]	1.70[b]

Values with different superscripts are significantly different (P<0.05). Sel-Plex (Se yeast from Alltech).

Table 2. Reproductive parameters at day 30 of pregnancy.

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synchronisation and stimulation of ovulation in gilts, prior to artificial insemination (AI) at fourth oestrus.

They noted intense metabolic activity and important treatment effects by 30 days of gestation, changes that could affect the success of programmes designed to improve sow prolificacy.

For example, selenite Se depressed thyroid metabolism, which is sensitive to both deficient and excess dietary Se. At day 30 of gestation, selenite-fed gilts exhibited significantly lower plasma T3, a Se-related hormone, and T4 (thyroxin), an effect that was not observed in controls or gilts fed Se yeast.

These data indicate that the form of Se is important, since both control and Se yeast groups were only exposed to organic Se, either endogenous (control) or supplemented (Se yeast), whereas the selenite group were also exposed to inorganic Se.

Gilts fed inorganic Se also had a significantly lower hormonal oestradiol peak just prior to ovulation than control or Se-yeast supplemented sows, again maybe due to the form of Se.

The data on blood Se-GSH-PX activity suggested a high metabolic demand for glutathione peroxidase around oestrus, mating, and early gestation, which only Se-supplemented gilts could meet.

Control gilts may have compensated for the shortage of anti-oxidant activity from Se-GSH-Px by releasing significantly more Vitamin E into the bloodstream (Fig. 3).

In anti-oxidant defence systems, there is a certain flexibility to replace Se with Vitamin E and vice versa.

Organic Se from Se yeast yielded significant improvements in mean embryo weight, length, protein and DNA content (Table 2).

In addition, organic Se produced significant improvements in litter anti-oxidant status, with improved embryonic Se, reduced variation in litter Vitamin E, and higher FRAP (ferric reducing anti-oxidant power).

Mean values	Control (endogenous organic Se, 0.2ppm)	Selenite (control diet + 0.3ppm Se from selenite)	Sel-Plex (control + 0.3ppm organic Se from Se yeast)
Total litter Se (µg)	2.88	2.74[a]	7.76[b]
Embryo Se (ng)	208.4[x]	196.5[ay]	298.1[by]
Variation in litter Se (%)	20.5[x]	15.6[y]	14.7[y]
Variation in litter vitamin E (%)	19.3	30.6[a]	19.4[b]
FRAP/embryo (ng)	127.4	120.6[a]	150.1[b]

Values with no common superscript are significantly different (P<0.05). Sel-Plex (Se yeast from Alltech).

Table 3. Anti-oxidant status of embryos at day 30 of pregnancy.

Se supplementation per se (from selenite or Se yeast) improved Se content of embryos and reduced variation in Se content within litters, but Se yeast was superior to selenite as a Se source (Table 3).

Homogeneity of litters was also studied, since as litters increase in size, the tendency is for wider variation in body weight.

Heterogeneous litters increase husbandry and management problems before and after weaning, and contribute to poor meat and carcase quality.

However, in the Canadian studies, litters at day 30 of gestation were very uniform, there were no significant differences in litter size, and there were few differences between treatments in the homogeneity of the parameters measured.

Prenatal strategies to improve litter homogeneity are certainly important, but scientists need a better understanding of physiological events during oestrus, mating and pregnancy.

The researchers concluded that organic Se from Se yeast made a significant contribution to sow Se status, by increasing blood Se concentration. Additionally, organic Se was important to optimise thyroid hormonal activities during early pregnancy.

The marked improvement in uterine transfer of Se to embryos in gilts supplemented with Se yeast resulted in better early embryonic development, possibly due to physiological hyperplasia (increased cell multiplication) in foetal tissues. The positive effects of organic Se in early pregnancy may have originated from the time of ovulation, perhaps by supporting the increased demand for anti-oxidant activity in animals with high metabolic activity related to the breeding cycle.

The overall conclusion was that modern prolific sows require fine tuning of the diet for optimum performance. Organic Se supplementation around oestrus, breeding and in early pregnancy demonstrates potential for improving reproductive performance, worthy of further investigation through practical trials and experience. ■

Fig. 2. Blood glutathione peroxidase status of gilts.

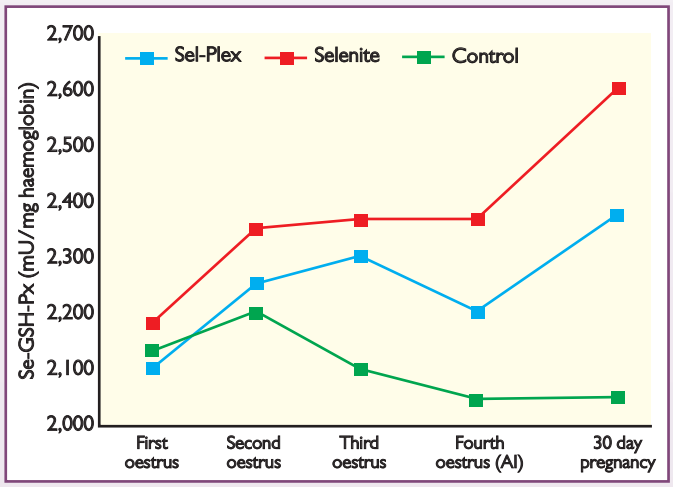

Fig. 3. Blood vitamin E in gilts around oestrus.