

## Organic Selenium in Swine Diets: Review and Discussion

Selenium (Se) is a trace mineral required by swine that must be supplemented in the diet. It is an integral part of several enzyme systems in the body, including glutathione peroxidase (GSH-Px). Peroxides are highly reactive molecules that form in the body as by-products of normal metabolism. GSH-Px inactivates peroxides. If they are not removed or made less reactive, peroxides will damage cell membranes, resulting in reduced performance. Vitamin E acts in concert with Se to reduce oxidative damage of tissue by peroxides. However, vitamin E's role is to reduce formation of peroxides rather than remove them once they are formed.

Selenium and vitamin E deficiency symptoms continue to be reported in swine, including sudden death, Mulberry heart disease, poor growth, gastric ulcers, muscular dystrophy, abnormal sperm cells in boars, and farrowing and milking problems in sows. Selenium deficiency may be more common when sodium selenite serves as the major source of total dietary Se, because selenite is not stored in body tissues of pigs as well as Se found in grains or grain by-products. Grains incorporate Se in an organic form, primarily as selenomethionine. Grains grown in Se-deficient soils have lower organic Se content. Selenium enriched yeast, which contains selenomethionine, was approved for use in swine diets in July 2002. Legal limits for Se addition to swine feeds remain at .30 ppm. However, using a more biologically active source of Se may prevent deficiency symptoms from occurring even when the same levels of total Se are supplemented in the diet.

Selenite is easily absorbed by pigs but is poorly retained in body tissues, resulting in high levels of Se excreted in urine. In contrast, selenomethionine is not as well absorbed from the digestive tract, resulting in higher levels of Se excreted in feces. However, once absorbed, selenomethionine is incorporated into body proteins in liver and muscle, resulting in higher Se retention and a more available body pool of Se. Selenium stored in body protein is not biologically active in pigs. It must be released during protein catabolism so it can be incorporated into GSH-Px. Selenium from selenite has a more immediate effect on GSH-Px activity, but having Se (as selenomethionine) stored in the body that can be released during protein catabolism is also of benefit.

Selenium deficiency symptoms may be more prevalent in pigs born to high producing mature sows, as Se content of sows' milk and colostrum may be compromised over time (Figure 1). Serum Se status in pigs from sows fed selenite as the only Se source tends to decrease as sows age (Figure 2). It is not known if feeding sows selenomethionine will mitigate the effect of parity on piglet Se status. However, several studies have shown that selenomethionine fed to sows results in improved Se content in sows' milk (Tables 1 and 2). Also, feeding selenomethionine to sows results in higher tissue levels of Se in pigs at birth and weaning (Table 3), suggesting that pigs from these sows will start the nursery period with improved Se status. Feeding sows selenomethionine vs. selenite had no effect on sow serum GSH-Px activity (Table 2) or weaned pig GSH-Px activity (Table 3). Thus, selenite appears to be more biologically available for sow serum GSH-Px activity, and organic Se is more effectively incorporated into sows' milk (Table 2).

Figure 1. Se Content of Colostrum and Milk by Parity

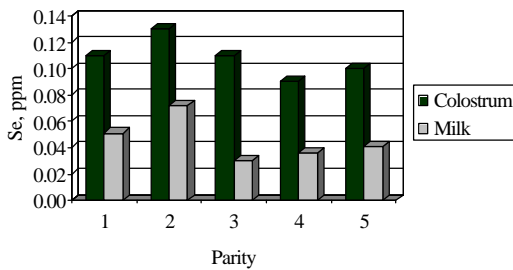
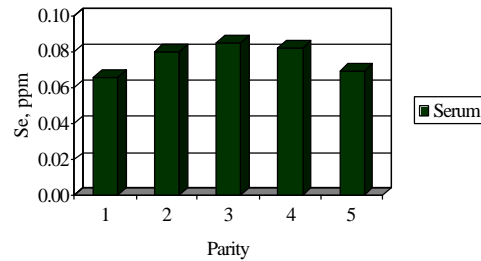


Figure 2. Se Content of Piglet Serum by Parity of Dam



Figures 1 and 2 adapted from Mahan, 1994. J. Anim. Sci. 72:2870.

Linear response of colostrum Se level ( $P < .01$ ).

Cubic response of milk Se level ( $P < .01$ ).

Quadratic response of piglet serum Se level ( $P < .01$ ).

Table 1. Se Source and Level Fed to Sows Affects Milk Se Content.

Item	Se from Na-Selenite, ppm		Se from Se-yeast, ppm	
	.1	.3	.1	.3
Gilts, no.	10	11	12	10
Milk Se, ppm				
0 d post farrow	.129	.110	.132	.116
7 d post farrow <sup>ab</sup>	.038	.048	.054	.081
14 d post farrow <sup>abc</sup>	.035	.047	.043	.078
21 d post farrow <sup>abc</sup>	.041	.044	.051	.090

Adapted from Mahan and Kim, 1996. J. Anim Sci 74:2711.

<sup>a</sup> Dietary Se level response ( $P < .01$ ).

<sup>b</sup> Dietary Se source response ( $P < .01$ ).

<sup>c</sup> Dietary Se level x Se source interaction ( $P < .01$ ).

Table 2. Se Source and Level Fed to Sows Affects Sow Serum GSH-Px Activity and Milk Se Content.

Item	Se source:	Basal	Inorganic (I)		Organic (O)		I + O
	Se level, ppm	0	.15	.30	.15	.30	.15 + .15
Sows, no.		3	3	3	3	3	3
Sow serum GSH-Px activity, units/mL							
7 d post farrow		.365 <sup>a</sup>	.497 <sup>b</sup>	.698 <sup>c</sup>	.464 <sup>b</sup>	.497 <sup>b</sup>	.398 <sup>ab</sup>
14 d post farrow		.381 <sup>a</sup>	.414 <sup>ab</sup>	.729 <sup>d</sup>	.481 <sup>b</sup>	.613 <sup>c</sup>	.646 <sup>c</sup>
Sows, no.		7	7	7	7	8	7
Colostrum Se, µg/mL		.093 <sup>a</sup>	.061 <sup>a</sup>	.093 <sup>a</sup>	.131 <sup>b</sup>	.188 <sup>c</sup>	.133 <sup>b</sup>
Milk Se, µg/mL							
7 d <sup>i</sup>		.027 <sup>e</sup>	.032 <sup>e</sup>	.036 <sup>f</sup>	.077 <sup>g</sup>	.111 <sup>h</sup>	.074 <sup>g</sup>
14 d <sup>i</sup>		.023 <sup>e</sup>	.027 <sup>e</sup>	.036 <sup>f</sup>	.072 <sup>g</sup>	.105 <sup>h</sup>	.067 <sup>g</sup>

Adapted from Mahan, 2000. J. Anim Sci 78:100.

<sup>abcd</sup> Means within a row with different superscripts differ ( $P < .05$ ).

<sup>efgh</sup> Means within a row with different superscripts differ ( $P < .01$ ).

<sup>i</sup> Dietary Se level x Se source interaction ( $P < .05$ ).

Table 3. Se Source and Level Fed to Sows Affects Piglet Tissue Se Content.

Item	Inorganic Se, ppm		Se-yeast, ppm	
	.1	.3	.1	.3
	----- Neonate -----			
Pigs, no. sampled	10	9	10	7
Loin Se, ppm <sup>ab</sup>	.039	.055	.068	.085
Liver Se, ppm	.236	.250	.283	.310
	----- Weanling pigs, 21-d of age -----			
Litters, no.	9	9	11	9
Serum Se, ppm <sup>ab</sup>	.062	.075	.082	.102
Serum GSH-Px, units/mL	.44	.51	.46	.44
Pigs, no. sampled	8	6	6	7
Loin Se, ppm <sup>abc</sup>	.101	.121	.129	.244
Liver Se, ppm <sup>b</sup>	.352	.388	.353	.509

Adapted from Mahan and Kim, 1996. J. Anim Sci 74:2711.

<sup>a</sup> Dietary Se level response (P<.05).

<sup>b</sup> Dietary Se source response (P<.01).

<sup>c</sup> Dietary Se level x Se source interaction (P<.05).

Trials published in scientific journals suggest that selenomethionine has no effect on sow reproductive performance, including number of pigs born total or live per litter, number of pigs weaned, or pig or litter weaning weights (Tables 4 and 5).

Table 4. Se Source and Level Fed to Sows Does Not Affect Reproductive Performance.

Item	Inorganic Se, ppm		Se-yeast, ppm	
	.1	.3	.1	.3
Gilts, no.	10	11	12	10
Total born, no.	11.2	11.9	10.8	11.6
Born live, no.	10.9	11.2	10.2	11.0
Weaned, no.	9.2	9.2	9.4	9.6
Litter wt, lb	124	117	120	119

Adapted from Mahan and Kim, 1996. J. Anim Sci 74:2711.

Responses are not different statistically.

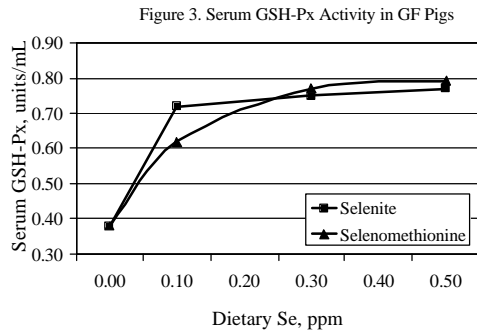
Table 5. Se Source and Level Fed to Sows Does Not Affect Reproductive Performance.

Item	Se source:	Basal	Inorganic (I)		Organic (O)		I + O
	Se level, ppm	0	.15	.30	.15	.30	.15 + .15
Sows, no.		7	7	7	7	8	7
Pigs born live, no./litter		12.9	11.4	10.7	11.7	13.0	9.4
Piglet birth wt, lb		3.1	2.9	2.9	3.2	2.9	3.4
Pigs weaned, no./litter		9.9	10.1	9.0	9.7	9.5	8.7
Piglet weaning wt, lb		9.0	9.3	9.2	9.2	8.9	8.9

Adapted from Mahan, 2000. J. Anim Sci 78:100.

Responses are not different statistically.

Because of the beneficial effects of organic Se fed to sows on Se status of pigs at birth and weaning, Akey is now offering products supplemented with Se yeast. These products have a portion of the Se supplied as selenomethionine and a portion supplied as selenite. This will give producers the opportunity for optimal returns for the cost of the product. It will also allow the majority of the benefits of the organic Se source in piglets while optimizing GSH-Px activity in sows. Total added Se remains at the legal maximum of .30 ppm.



Supplying sows with selenomethionine improves Se status via body protein storage in pigs at birth and weaning. To protect pigs from oxidative damage of tissues during the highly stressful post-weaning period, it is very important that serum GSH-Px activity be maximized. To achieve this objective, inorganic Se is the best option (Figure 3). Thus, Akey will continue to use sodium selenite as the primary Se source in diets for nursery pigs.

Figure 3 adapted from Mahan and Parrett, 1996. *J. Anim. Sci.* 74:2967.  
Se source by level interaction,  $P < .01$ .

If you have questions or wish to discuss product options with Se yeast, please contact your Akey Account Manager or the Akey Technical Services Team at (800) 392-8324.