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Use Selenium Cautiously When Feeding Livestock

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Selenium (Se) is an essential dietary nutrient for all livestock. However, it can be toxic when fed to animals at excessive amounts.

The Food and Drug Administration (FDA) has approved the addition of Se to poultry, swine, sheep and cattle rations. These decisions were preceded by several years of research and debate which focused primarily on the toxic effects of Se, which included possible carcinogenicity (cancer).

Because of the lack of sufficient evidence of carcinogenicity, and the positive evidence that Se is an essential dietary requirement for many animal species, scientists favor Se-supplementation of animal feeds. FDA approved levels of Se for addition to diets for different farm animals are shown in Table 1. Because Se can be chronically toxic at relatively low concentrations (as low as 3.0 to 5.0 ppm), producers should make sure that excess amounts of Se are not fed.

Table 1. Levels of Se approved by FDA for addition to animal feeds.

Beef Cattle	May add to complete feed at a level less than or equal to 0.1 ppm (parts per million), or in a feed supplement not to exceed 1 mg Se/head/day. It can be added up to 20 ppm in salt mineral mixture for free choice feeding at a rate not to exceed 1 mg/head/day.
Dairy Cattle	May add to complete ration at a level not to exceed 0.1 ppm Se.
Sheep	May add in complete feed at a level not to exceed 0.1 ppm, or it can be added in a feed supplement for limited feeding at a level not to exceed 0.23 mg Se/head/day. Also approved for free choice feeding in salt mineral mix up to 30 ppm at rates not exceeding 0.23 mg Se/day.
Swine	May add up to 0.1 ppm Se to total ration as sodium selenite or sodium selenate.
Chickens	May add up to 0.1 ppm Se in total ration as sodium selenite or sodium selenate.
Turkeys	May add up to 0.2 ppm Se as sodium selenite or sodium selenate to total ration.

Commercial Se Supplements

Se is available for addition to animal feeds in a variety of forms as listed in Table 2. **Most Se-fortified feed supplement is formulated so that animals can receive their daily allowance of Se from that source alone.** For example, cattle receiving Se in their protein supplement may not need added Se in their mineral mix or a Se premix added to their ration.

Table 2. Commercially available sources of Se.

Cattle	— commercial protein supplement—usually contain about 1 ppm — mineral mix containing 15 to 25 ppm Se — trace mineralized salt containing 20 ppm Se — special Se premix containing 200 ppm Se — liquid molasses supplements for lick tanks
Sheep	— mineral mixes containing 30 ppm Se
Swine	— trace mineral mixes added to complete feed to achieve 0.1 ppm Se — special Se premix (50 lb bags containing 200 ppm Se; same as for cattle)
Poultry	— for chickens 0-16 weeks old, Se in vitamin-mineral premix — available in 2-5 lb packets for addition to vitamin-mineral premix or in a packet to add to a given amount of feed
Turkeys	— vitamin-mineral premixes or packets for addition to premixes added at a rate to achieve 0.2 ppm Se in the ration

Se Injections

Occasionally, Se-injections are recommended for animals under certain conditions. Newborn calves may receive a single injection of 5 mg of Se for the prevention of white muscle disease. Cows may be injected with a commercial product,

such as Myo-sel (formerly Mu-Se) 3 weeks prepartum, and again after calving (20 cc/injection may furnish 0.25, 1.0, 2.5 or 5 mg of Se, depending upon concentration in the specific product). These injections may be given even when the diet contains the recommended amounts of added Se. Injecting more than these amounts *is not recommended.* **Inject Se only according to the recommendation and direction of your veterinarian.**

Natural Sources of Se

Se naturally present in forages and grains varies greatly. There is a wide variation in the amount of Se naturally present in plants because of the differences in Se content in soils. In Michigan the amount of Se from these natural sources is low, and Michigan-grown feeds will probably not furnish the animal with the needed amounts of Se. However, the Se in some natural feeds (organic Se) may be more available than the selenium in sodium selenite that is added to feeds. Some diets containing large amounts of brewers' or distiller's grains, and/or cereals or forages grown on soils high in Se will provide the necessary amount in the animals' diet without further supplementation.

Producers may wish to have their forage or feeds analyzed to determine actual Se content. This can be done by sending an identified sample to a private laboratory that performs feed analysis services. Contact your local county extension office for assistance. Find out not only the best place to send the sample, but also important details related to sample collection, storage and shipping.

Se Toxicity

Se-supplements containing high levels of Se and stored on the farm present a serious hazard. Animals breaking into bags and ingesting an excessive amount of a Se feed supplement can be poisoned. *Bags of Se supplements must be stored to prevent such accidents.* Signs of poisoning are listed in Table 3.

Over-addition of Se to the ration may result in toxicity. Producers must add **only** the recommended amount of Se-premix, Se-fortified protein supplement or trace mineral salt containing Se to the animal diet.

Different types of Se toxicity can occur in animals, depending on the amount and duration of exposure. Animals may become severely ill or die from ingesting one large dose of Se, or they may show signs of progressive illness from ingesting smaller amounts over a longer period of time (see Table 3).

After toxicity occurs, recovery may be possible if Se sources are removed. Consult a veterinarian if toxicity is suspected.

Blood Testing for Determining Se Levels in Animals

The concentration of Se in blood is a good indicator of either Se deficiency or adequacy. Blood plasma levels of 0.01 to 0.05 ppm indicate a Se deficiency, and that Se should then be added to the diet. A blood level of about 0.1 ppm is desirable. Blood levels of about 0.2 ppm indicate that the animal is receiving too much Se and that a toxic situation may exist.

The best way to determine if cattle are receiving the proper amount of Se is to have their blood analyzed. A veterinarian can obtain blood samples from animals and send them to the MSU Animal Diagnostic Laboratory, P.O. Box 30076, Lansing, MI 48909. The charge (on January 1, 1982) is $8.00 per single sample and $5.00 each for multiple samples. Sample from 6 to 12 animals to obtain a reasonable estimate of animal variation and dietary adequacy.

Know the Daily Se Intake of Your Livestock

Knowledge of the amount of Se that animals are consuming daily is important because:

- Although Se is a required nutrient, it can be toxic at higher amounts.
- The range between the required level and the toxic level in diets is relatively narrow (0.1 ppm is required for normal health, while 3.0 to 5.0 ppm is toxic after prolonged feeding).

Sources of Se for dairy cattle which contribute to the total amount of Se consumed include:

- forage
- grain
- feed with added Se
- trace mineral mix
- Se-injections
- other sources.

How to Determine Daily Se Intake

A producer can calculate the daily amount of added Se animals are receiving to determine whether the level is within the safe range (see Table 4). In order to do this, the following must be done:

1. Find out how much Se is provided by injections, if they are given. These injections alone may be sufficient. On the other hand, carefully consider if dietary supplementation alone may be adequate if injections are discontinued.
2. Determine how much Se is provided daily in **Se-supplemented** feeds by totalling the Se content of all supplements.
3. Finally, determine the total amount of Se given to the animal daily by adding the amounts from all sources. This total should not exceed the recommended level (see Table 1).

The following calculations demonstrate how to determine Se supplementation provided for dairy cattle. Similar calculations are used for other species. The necessary information is the amount of a Se-containing feed fed and its Se content.

1. Assume a cow received 5 lbs of a 38% protein supplement that contains 1 ppm Se. One can calculate the amount of Se in the 5 lbs as follows:
   a) 5 lbs × 0.454 (kg/lb) = 2.27 kg
   b) 1 ppm Se = 1 mg/kg Se
   c) 1 mg/kg Se × 2.27 kg = 2.27 mg Se

   Therefore, 5 lbs of this protein supplement furnishes 2.27 mg Se.
2. Assume a cow's ration furnishes 0.21 lb/cow/day of trace mineral (TM) salt containing 20 ppm Se. The amount of Se consumed per head per day from this source is calculated as follows:
   a) 0.21 lbs × 0.454 kg/lb = 0.095 kg
   b) 20 ppm Se = 20 mg Se/kg
   c) 20 mg Se/kg × 0.095 kg = 1.90 mg Se/cow/day
3. Assume dairy cattle total mixed ration (TMR) contains 46 lbs of dry matter. The amount of Se-supplement containing 200 ppm (90 mg/Se/lb) that should be added to the daily ration is calculated as follows:
   a) 2 mg Se/head/day desired
   b) 2 mg Se ÷ 90 mg/lb = 0.022 lbs of supplement

   Therefore, 0.022 lbs of Se supplement containing 200 ppm should be added to the 46 lb of DM in the TMR to achieve 2 mg Se/cow/day.
4. Assume that the total mixed ration fed to dairy cattle contains 46 lbs of dry matter. The amount of Se supplement containing 200 ppm (90 mg/Se/lb) to add to the daily ration to achieve a 0.1 ppm added Se on that total mixed ration is calculated as follows:
   a) 46 lbs DM × 0.454 (kg/lb) = 20.9 kg DM fed
   b) 0.1 mg Se/kg feed desired, which converts to 2.09 mg Se/cow/day (0.1 mg Se/kg feed × 20.9 kg DM = 2.09 mg)
   c) The supplement containing 90 mg Se/lb converts to 0.0232 lbs (2.09 ÷ 90 mg Se/lb feed = 0.0232 lbs) of that supplement needed/cow/day
   d) To determine the total amount of supplement needed, multiply the quantity of supplement by the number of cows in the herd. For example, for 62 cows, 1.39 lbs (62 cows × 0.0232 lbs/cow/day = 1.39 lbs) of Se supplement/62 cows/day is needed.

   Compare the daily Se total with the satisfactory amount listed in Table 4.

Note that the total in these examples (1.90 to 2 mg Se) is approximately the maximum allowed by FDA regulations. Blood Se concentrations may be desirable to determine if the added amount is sufficient in Michigan livestock.

Table 3. Signs of toxicity from excess Se ingestion.

High level	— ingestion of one large amount of Se (acute poisoning)
	abnormal, drooping posture
	diarrhea
	elevated temperature
	increased urine excretion
	labored breathing
	weakness and collapse
	death
Intermediate level	— ingestion of much higher than required level (100 ×) of Se for several weeks (subchronic poisoning)
	aimless wandering, stumbling
	impaired vision
	subnormal temperature
	swollen, inflamed eyelids
	labored breathing
	paralysis
	possibly death
Low level	— ingestion of higher than required level (50 ×) of Se for several months (chronic poisoning)
	lack of vitality (ill-thrift)
	hair loss
	emaciation
	hoof malformations
	sloughing of hooves
	stiffness of joints and lameness

Table 4. Recommended minimum and maximum amount of Se for farm animals.[1]

Species	Source	Minimum daily requirement	Maximum total recommended by FDA[2]	Toxic level	
		ppm in feed	*mg/head/day*	*ppm in feed*	*mg/head/day*
Dairy Cattle	NRC, 1971a	0.1	2	3-5	30-60
Beef cattle	NRC, 1976	0.1	1	10-30	100-300
Sheep	NRC, 1975	0.1	0.23	3-20	7-50
Swine	NRC, 1973a	0.1	—	5-10	8-16
Chickens	NRC, 1981b	0.1	—	2	?
Turkeys (0-8)	NRC, 1971b	0.2	—	—	?

[1]Ammerman, C.B. and P.P. Henry, "Current Status of Selenium for Ruminants," Feedstuffs, March 13, 1978.

[2]Note: 2 ppm (2 mg/head/day) is suuggested as the maximum tolerable level for all species (NRC, 1980).

Summary

1. Se is available for farm animals from a variety of commercial sources, as well as being provided by natural sources. Se in the total ration can exceed the recommended amount for farm animals.
2. Although Se is an essential nutrient, at higher levels it can be toxic. To protect your animals from ingesting potentially harmful levels of Se:
   - Take careful precautions in storing Se supplements.
   - Do not feed more than recommended amounts of Se.
   - Strictly follow label mixing directions in adding Se to the ration.
   - Do not feed toxic amounts of Se.

Farm animals will benefit from receiving Se in their ration ONLY if proper care is exercised in supplementing the ration with this essential nutrient.

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