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Preventing Selenium Poisoning in Growing and Fattening Pigs

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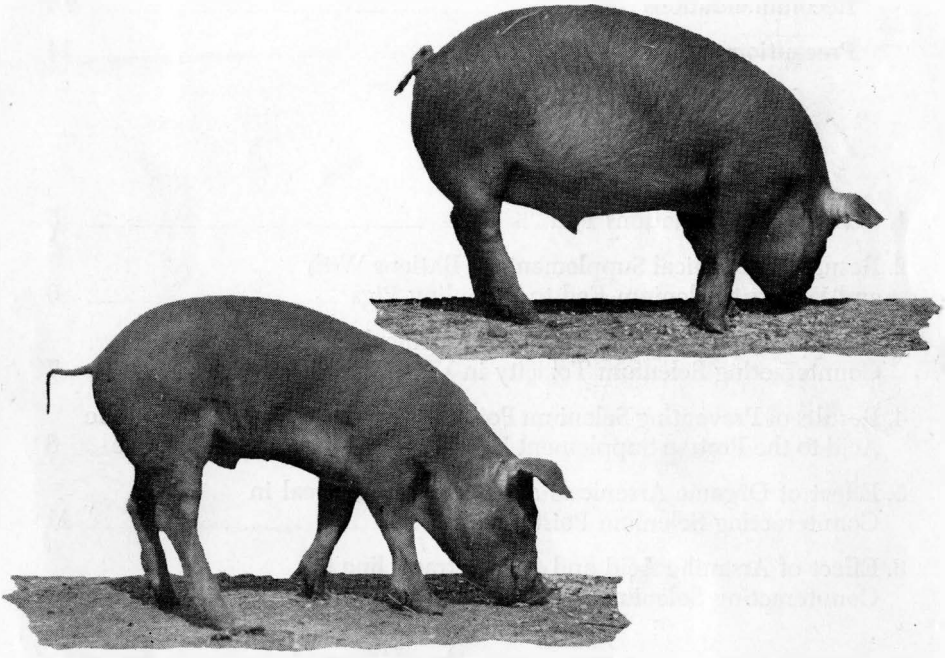
PREVENTING *Selenium* POISONING

IN GROWING AND FATTENING PIGS



ANIMAL HUSBANDRY AND
BIOCHEMISTRY DEPARTMENTS
AGRICULTURAL EXPERIMENT STATION
SOUTH DAKOTA STATE COLLEGE
BROOKINGS

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COVER—Selenium poisoning in pigs can be prevented. These pigs were of near similar weights at the beginning of an experiment. At the end of 8 weeks on a ration that contained selenium, weights were 41 and 125 pounds. The heavier pig received arsanilic acid to counteract selenium poisoning.

Preventing Selenium Poisoning

IN GROWING AND FATTENING PIGS

RICHARD C. WAHLSTROM, LESLIE D. KAMSTRA, and OSCAR E. OLSON[1]

Introduction

The condition commonly referred to as alkali disease has been known for a number of years to be the result of chronic poisoning by selenium. South Dakota Agricultural Experiment Station bulletin 311, published in 1937, explained the cause for this disease and thoroughly described the symptoms exhibited by various farm animals. The work reported here was started in 1953. At that time effective and practical control measures had not been found.

Swine affected by chronic selenium poisoning lose their appetite and fail to grow normally. They develop an inflammation and cracking at the junction of the hoof and skin and become sore-footed. They may lose hair from their bodies and even die.

There are great individual differences in the susceptibility of swine to selenium poisoning. On the same seleniferous rations, some animals in a lot may appear normal while others exhibit severe symptoms and die. Various intermediate stages are observed also.

In 1941, Moxon[2] reported that low levels of sodium arsenite in seleniferous rations fed to hogs would prevent poisoning by selenium, an observation which had already been made with rats. Sodium arsenite is very toxic. The arsenic accumulates in body tissues giving meats an excessively high arsenic content. For these reasons the use of sodium arsenite has not been recommended for swine on seleniferous rations.

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Grateful acknowledgment is made to Abbott Laboratories for supplying the arsanilic acid (Pro-Gen 20%); to Dr. Salsbury's Laboratories, Charles City, Iowa, for the 3-nitro-4-hydroxyphenylarsonic acid; to Merck and Company, Inc., Rahway, New Jersey, for the B-vitamins; to NOPCO Chemical Company, Harrison, New Jersey, for vitamins A and D; and to American Cyanamid Company, Pearl River, New York, for the chlortetracycline.

[2]Proc. S. Dak. Acad. Sci. **21**:34.

Organic Arsenicals

Within the past decade, certain organic forms of arsenic have been found to stimulate the growth of swine and poultry. These compounds are referred to as organic arsenicals; the two now being commonly used in mixed feeds are arsanilic acid and 3-nitro-4-hydroxyphenylarsonic acid, hereafter called 3-nitro. These compounds are of such a nature that the arsenic they contain is largely excreted soon after being consumed. Thus, by proper feeding practices excessive accumulations of this toxic element in the tissues are avoided. Furthermore, the compounds are much less toxic than sodium arsenite, and it appeared that they might be of some value in controlling selenium poisoning.

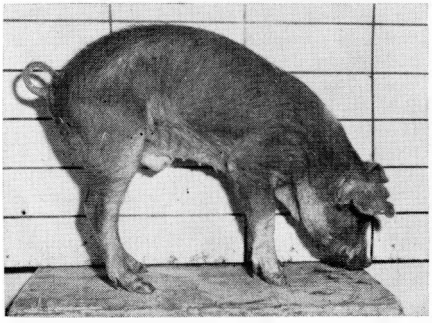
Preliminary experiments with rats were conducted in the laboratory. It was found that organic arsenicals would give good protection against the toxicity of naturally seleniferous grains or of rations to which sodium selenite had been added. Similar findings were made with chicks, and it appeared that the organic arsenicals might be useful in controlling selenium poisoning in swine.

Report Five Trials

Five trials with growing-fattening hogs are reported in this bulletin. Three of these dealt with the use of organic arsenicals alone in seleniferous rations. In one trial, combinations of the arsenicals and linseed oil meal were studied. In another trial chlortetracycline (Aureomycin) and arsanilic acid were used alone and in combination to determine their value in preventing selenium poisoning. Results of these trials are discussed here and recommendations for the use of arsenicals in rations for growing-fattening swine in seleniferous areas are given.

Throughout the experimental work, rations artificially selenized with sodium selenite have been used rather than seleniferous grains. There is considerable evidence to show that the two forms of selenium have about the same degree of toxicity, produce the same

Symptoms of selenium poisoning include unthriftiness and a separation of the hoofs from the skin.



symptoms, and respond to the same control measures. Therefore, it was decided to use rations containing selenium added as sodium selenite for better control and greater convenience.

Experimental

Three trials (1, 2, and 5) were conducted with 102 purebred weanling pigs to study the effect of organic arsenicals in preventing selenium poisoning in pigs. The pigs were allotted as equally as possible according to breed, litter, and weight to the various treatments. All pigs were kept in a barn with concrete floored pens and had access to adjacent outside paved runways. The rations were self-fed and an automatic water supply was provided.

Composition of the basal rations fed in the first two trials is given in table 1. The complete mixed rations fed in these two trials were identical except for selenium content. In trial 1 three lots were fed the ration without added selenium, while the other three lots received selenium at 7 parts per million of total ration. In trial 2, selenium at 10 parts per million was added to all rations.

In trial 5 the pigs were self-fed ground yellow corn and a protein supplement free-choice. The protein supplement was composed of 50 percent soybean oil meal, 45 percent tankage, and 5 percent of a simple mineral mixture (equal parts of steamed bone meal, ground limestone, and trace mineralized salt). A B-vitamin supplement was added to supply the following per ton of supplement: 54 grams niacin, 24 grams pantothenic acid, 12 grams riboflavin, 60 grams choline, and 36 micrograms vitamin B_{12}. For the lots fed selenium in trial 5, the selenium was added to the ground corn at a level of 11 parts per million.

The arsenical compounds used in these trials were arsanilic acid and 3-nitro. Where selenium was added to the rations, it was added as sodium selenite.

Table 1. Composition of Rations Fed (Percent)

	Trial and Ration Number			
	1, 4	2	3	
	40	41	42	43
Ground yellow corn	82.0	82.0	79.7	79.7
Soybean oil meal	11.2	11.2	14.0	—
Linseed oil meal	—	—	—	14.0
Tankage	5.6	5.6	5.0	5.0
Steamed bone meal	0.7	0.7	0.8	0.8
Trace mineral salt	0.5	0.5	0.5	0.5
Vitamin supplement*	+	+	+	+
Selenium (p.p.m.)†	0	10	13	13

*Supplied the following to each pound of ration: 6 mg. niacin, 5 mg. pantothenic acid, 1 mg. riboflavin, 125 mg. choline chloride, 4 mcg. vitamin B_{12}, 1,000 USP units vitamin A, and 125 USP units vitamin D.

†Added as sodium selenite.

Table 2. Results of Arsenical Supplements in Rations With and Without Selenium Fed to Weanling Pigs (Trial 1, Winter 1953-54)

	Lot Number and Treatment					
	1 Basal	2 Basal+ .01% Arsanilic Acid	3 Basal+ .005% 3-nitro	4 Basal+ Selen-ium*	5 Basal+ Selenium+ .01% Arsan-ilic Acid	6 Basal+ Selenium+ .005% 3-nitro
Number of pigs	5	4†	5	4‡	4§	5
Av. initial wt., lb.	30	31	30	32	30	30
Av. final wt., lb.	189	203	198	164	176	201
Av. number days on test	104	108	102	108	107	104
Av. daily gain, lb.	1.53	1.59	1.64	1.22	1.36	1.64
Av. daily feed per pig, lb.	5.04	5.52	5.33	3.81	4.36	5.36
Av. feed per cwt. gain, lb.	329	348	325	313	320	327

*Supplied 7 p.p.m. of selenium in ration.
†Does not include one unthrifty pig removed during the test.
‡Does not include one pig that died due to selenium poisoning.
§Does not include one pig that died due to gastric hemorrhage.

Results and Discussion

Results of the first trial are summarized in table 2. A slightly faster rate of gain was obtained when arsanilic acid and 3-nitro were added to the basal ration which did not contain selenium. This small increase in rate of gain of lots 2 and 3 compared to lot 1 is similar to the results of other workers and indicates that there was no toxicity due to the arsenicals when fed at the levels used in this trial. Arsanilic acid was fed at a level of 0.01 percent of the ration and 3-nitro at a 0.005 percent level.

The effectiveness of the two arsenicals in protecting against selenium poisoning is shown in the growth of lots 5 and 6 compared to lot 4. The pigs in lot 4, which received the selenium ration, gained 1.22 pounds per day compared to a daily gain of 1.36 and 1.64 pounds when arsanilic acid and 3-nitro, respectively, were added to the selenium ration. The rate of gain of lot 4 would be even less if the data had been included for the one pig that died due to selenium poisoning.

Three of the five pigs in lot 4 developed selenium toxicity symptoms during the trial. Two Duroc pigs showed loss of hair, cracked hoofs, and emaciation, and a Hampshire pig became lame and showed some hoof cracking. These symptoms occurred after about 5 weeks on the selenium ration. One of the Duroc pigs died 5 weeks later while the other pigs showed some improvement by the end of the trial.

Further evidence for the protective effect of arsanilic acid and 3-nitro is that none of the pigs fed these arsenicals in the selenium ra-

tion (lots 5 and 6) showed any selenium poisoning symptoms. Arsanilic acid did not appear to give complete protection in this trial, as the pigs in lot 4 gained 1.36 pounds per day while those in lot 2, which received the same ration without selenium, gained 1.59 pounds per day. Good protection was given by 3-nitro, as is evidenced by equal rates of gain for lots 3 and 6, which were fed this arsenical with and without selenium, respectively.

Data for the second trial are shown in table 3. This trial was conducted to obtain further information on the value of arsenical supplementation, at various levels, in preventing selenium poisoning in pigs.

A significantly greater rate of gain was shown by the pigs receiving either of the arsenicals at the higher levels (lots 2 and 4) than by the control lot (lot 1). This difference was more evident at the end of 10 weeks when all the pigs were still on the experiment. At this time the control pigs had gained an average of 60 pounds while the lots that were receiving the arsenicals had an average gain of from 67 to 100 pounds per pig.

Arsanilic acid at a level of 0.02 percent (lot 2) and 3-nitro at the 0.005 percent level (lot 4) were equally effective in preventing selenium toxicity in this trial. Both of these arsenicals were well tolerated at these levels.

The level of arsanilic acid fed to lot 3 was reduced to one-half that fed lot 2. At this level the protection was not quite as complete, but the slower rate of gain was due mainly to the poor gain of one pig during the first few weeks of the trial.

Although several pigs in lot 5 gained very slowly, 3-nitro at the 0.0025 percent level apparently gave some protection; the pigs did not show the visible signs of selenium poisoning exhibited by two of the pigs in lot 1.

Table 3. Comparison of Different Levels of Arsenicals in Counteracting Selenium Toxicity in Weanling Pigs (Trial 2, Summer 1954)

	Lot Number and Treatment				
	1	2	3	4	5
	Basal*	Basal +.02% Arsanilic Acid	Basal +.01% Arsanilic Acid	Basal +.005% 3-nitro	Basal +.0025% 3-nitro
Number of pigs	8	8	8	8	8
Av. initial wt., lb.	29	29	29	29	29
Av. 10-week wt., lb.	89	129†	116	122‡	96
Av. final wt., lb.	152§	170	159	167	132
Av. daily gain, lb.	1.28§	1.49‡	1.37	1.46‡	1.09
Av. daily feed per pig, lb.	3.91	5.00	4.50	4.43	3.80
Av. feed per cwt. gain, lb.	368	336	328	303	349

*The basal ration contained 10 p.p.m. of selenium.
†Significant at 1 percent level.
‡Significant at 5 percent level.
§Does not include two pigs removed and autopsied on 84th day.

It appears possible that a breed difference in susceptibility to selenium poisoning may exist since in both trials the Duroc pigs were most severely affected. Much more evidence is necessary to establish this, however, as the number of pigs used from some breeds has been quite small. It has been noted that breed differences in susceptibility to selenium poisoning exist in chicks.

A great deal of variation also was found in the growth of individual pigs in the lots receiving selenium or selenium plus the lower levels of arsenicals. Some pigs apparently are more susceptible to selenium toxicity than others. The smaller pigs in a lot are more apt to be affected than the larger pigs.

The effect of selenium on efficiency of gains was not consistent. In trial 1 the pigs fed the basal ration plus selenium actually made the most efficient gains. In the second trial this group required the most feed per pound of gain. The main cause of the slower growth of those pigs fed selenium and that did not show external selenium toxicity symptoms seemed to be due to a reduced feed intake. Supplementing the selenium ration with arsenicals increased the feed consumption.

Table 4 is a summary of the average performance of the pigs in trial 5. The addition of 11 parts per million of selenium to the ground corn fed to lot 2 resulted in a significantly slower rate of gain. Arsanilic acid (0.06 percent) in the protein supplement appeared to be of benefit when the ground corn contained selenium. This is shown by comparing lots 2 and 3. The pigs in lot 3 gained 0.28 pound per day more than those in lot 2, and they gained at approximately the same rate as the control pigs (lot 1).

This trial was conducted for 98 days during the abnormally cold

Table 4. Results of Preventing Selenium Poisoning in Pigs by Adding Arsanilic Acid to the Protein Supplement When Pigs Were Fed Free-Choice (Trial 5, Winter 1955-56)

	Lot 1 Basal	Lot 2 Selenium*	Lot 3 Selenium*+ Arsanilic Acid†	Lot 4 Arsanilic Acid†
Number of Pigs	8	7‡	7‡	8
Av. initial wt., lb.	26.5	26.7	26.9	26.5
Av. final wt., lb.	141.5	116.3	143.3	147.9
Av. daily gain, lb.	1.17§	0.91	1.19§	1.24§
Av. daily feed per pig, lb.				
Ground corn	3.33	2.36	2.85	3.26
Protein supplement	0.94	1.06	1.15	1.20
Total feed	4.27	3.42	4.00	4.46
Av. feed per cwt. gain, lb.	364	383	337	360

*Selenium added to the corn to supply 11 p.p.m. of selenium.
†.06 percent arsanilic acid added to each ton of supplement.
‡Two pigs died from causes not associated with selenium poisoning.
§Significantly greater at the 5 percent level than lot 2.

winter of 1955-56. This may be a reason for the slightly lower daily feed consumption observed and undoubtedly is a factor in the slower gains made by all pigs in this trial.

The two lots fed the ground corn without selenium consumed about 3.3 pounds of corn daily, while the pigs fed the ground corn containing selenium consumed only 2.6 pounds of corn daily. This is evidence that feed containing selenium is unpalatable to pigs. The ratio of the consumption of protein supplement to corn was 1:3.54, 1:2.23, 1:2.48, and 1:2.72 for lots 1 to 4, respectively. The pigs in this trial consumed excessive amounts of protein supplement, especially when the corn contained selenium.

In other work at this station with nonseleniferous rations, very little difference in rate or efficiency of gains was found when pigs were fed free-choice or mixed rations. This fact, together with the results of the three trials presented here, indicates that it would be more economical to add arsenicals to a complete mixed ration rather than to the protein supplement to prevent selenium poisoning in pigs.

Arsenicals with LOM or Chlortetracycline

Experimental

Forty-eight pigs were used in trial 3 to study the effect of combinations of linseed oil meal and arsenicals in preventing selenium poisoning. These pigs were allotted into 12 lots of four pigs each. Two lots were then assigned to each of the six treatments. Lots 1, 3, and 5 received basal ration No. 42 and lots 2, 4, and 6 were fed ration No. 43. The composition of these rations is shown in table 1 and the experimental treatments given each lot are shown in table 5.

In the fourth trial 40 purebred Duroc pigs were grouped into five lots and fed ration No. 40. The five lots were fed at follows: lot 1—basal ration; lot 2—basal plus selenium (10 parts per million); lot 3—basal plus selenium plus arsanilic acid (0.01 percent); lot 4—basal plus selenium plus chlortetracycline (10 grams per ton); and lot 5—basal plus selenium plus arsanilic acid plus chlortetracycline.

Management practices for these two trials were similar to those described for trials 1, 2, and 5.

Results and Discussion

Results of trial 3 are presented in table 5. The effectiveness of the two arsenicals in protecting against selenium toxicity can be noted by comparing the rate of gain of lots 1 and 2 with lots 3, 4, 5, and 6.

The four lots receiving arsanilic acid and 3-nitro gained 0.2 to 0.25 pound per day more than those pigs that did not receive these arsenicals in their feed. Arsanilic acid gave better protection than 3-nitro when fed with soybean meal in this trial.

Two pigs in lot 5, which received arsanilic acid at a level of 0.01 percent of the ration, exhibited only mild symptoms. Three pigs in lot 3, fed 0.005 percent 3-nitro, showed quite severe symptoms. In fact, two of the pigs were removed from the experiment and autopsied. If the data from these two pigs were included it would bring down the average daily gain of this group considerably. This is the only trial in which visible selenium poisoning symptoms appeared in pigs fed selenium rations plus organic arsenicals. This was assumed to be due, at least in part, to the higher level of selenium (13 parts per million) used in this trial.

The toxicity of the ration was reduced by replacing soybean oil meal with linseed oil meal. It will be noted from table 5 that only one of the pigs receiving ration No. 43 (containing linseed oil meal) showed selenium poisoning symptoms. On the other hand, nine of the pigs receiving ration No. 42 (containing soybean oil meal) showed some signs of selenium poisoning. There was no difference in rate of gain between those pigs fed linseed or soybean meal. But the pigs fed soybean meal required approximately 50 pounds less feed per hundredweight of gain and consumed less feed per day than did those fed the linseed oil meal ration.

Table 6 summarizes the results of trial 4. As in the previous trials, arsanilic acid was effective in preventing selenium poisoning. This is

Table 5. Effect of Organic Arsenicals and Linseed Oil Meal in Counteracting Selenium Poisoning in Pigs (Trial 3, Winter 1954-55)

	Lot and Ration Number, Treatment					
	1 42 (SOM)	2 43 (LOM)	3 42+ 3-nitro	4 43+ 3-nitro	5 42+ Arsanilic Acid	6 43+ Arsanilic Acid
No. pigs started*	8	8	8	8	8	8
No. pigs finished	8	8	6	8	7	8
Av. initial wt., lb.	29.1	29.0	28.9	29.0	29.0	29.0
Av. final wt., lb.	112.1	112.0	134.3†	131.8	132.1†	128.8
Av. daily gain, lb.	0.99	0.99	1.25†	1.22	1.24†	1.19
Av. daily feed, lb.	3.32	3.97	3.06	4.18	3.48	4.12
Feed/cwt. gain, lb.	344	403	300	344	298	347
No. pigs showing selenium toxicity symptoms	4	1	3	0	2	0

*Two replicates of four pigs each.
†Data for pigs that finished the experiment.

Table 6. Effect of Arsanilic Acid and Chlortetracycline in Counteracting Selenium Poisoning in Swine (Trial 4, Summer 1955)

	Lot Number and Treatment				
	1 Basal	2 Basal+ Selenium*	3 Basal+ Selenium+ Arsanilic Acid	4 Basal+ Selenium+ Chlortetra- cycline	5 Basal+ Selenium+ Arsanilic Acid+ Chlortetracycline
No. pigs started	8	8	8	8	8
No. pigs finished	8	8	8	5	8
Av. initial wt., lb.	26.4	26.2	26.1	26.4	26.4
Av. final wt., lb.	156.2	137.2	154.8	166.2†	170.5
Av. daily gain, lb.	1.33	1.13	1.31	1.45†	1.48
Av. daily feed, lb.	4.39	3.49	4.26	4.07	4.90
Feed/cwt. gain, lb.	330	308	324	328	333
No. pigs showing selenium toxicity symptoms	0	2	0	4	0

*Supplied 10 p.p.m. of selenium in ration.
†Data for pigs that finished the experiment.

indicated by comparing the daily gains of lots 1, 2, and 3. Adding selenium to the basal ration decreased the rate of gain from 1.33 to 1.13 pounds per day. The addition of arsanilic acid to the ration containing selenium restored the rate of gain to approximately that of the controls. Further evidence of the protective effect of arsanilic acid is that none of the pigs in lots 3 or 5 showed any selenium poisoning symptoms.

There did not appear to be any value in feeding an antibiotic (chlortetracyline) for prevention of selenium poisoning. Two of the pigs in lot 4 that received the antibiotic developed severe selenium symptoms and were removed from the test. One other pig died in this lot from unknown causes.

Although the antibiotic did not protect against the selenium poisoning, it produced a growth response in those pigs not affected by the selenium. This is particularly true in lot 5, which received the combination of arsanilic acid and chlortetracycline.

It is believed that the arsanilic acid protected against the selenium and that the antibiotic caused an additional growth response. This would appear to be the case since the growth rate of the pigs receiving the selenium ration plus arsanilic acid (lot 3) was equal to the rate of gain of the controls (lot 1), while the pigs receiving the selenium ration plus arsanilic acid and chlortetracycline (lot 5) gained at an average rate approximately 10 percent greater than lots 1 or 3.

In this trial we also attempted to determine if pigs that had been quite severely poisoned by selenium would grow at a normal rate if fed a well-balanced ration.

The two pigs removed from lot 4 had been on test for 7 weeks. At this time they weighed only 26.5 pounds and showed all the external selenium toxicity symptoms as described previously. After being placed on a nonseleniferous ration the growth response of these two pigs was immediate. Their average gain was 1.86 pounds per day up to a weight of 205 pounds. At slaughter the only visible signs of selenium poisoning were the cracked areas on the hoofs, which had healed, and sore-footedness in one of the pigs.

Summary of Experimental Work

All experiments conducted to date have shown an obvious advantage in feeding organic arsenicals to swine on seleniferous rations. Gains in weight, feed consumption, freedom from symptoms of selenium toxicity, and survival have consistently been better for the hogs fed the arsenicals.

Rations containing three levels of selenium were used: 7 parts per million, 10 parts per million, and 13 parts per million. This range probably covers most of the cases where seleniferous feeds are being used. Protection against selenium poisoning was obtained at all three levels.

However, a few animals receiving arsenicals did show symptoms of selenium poisoning on the high level of selenium. Complete protection should not necessarily, therefore, be expected. Furthermore, rations used in seleniferous areas may sometimes contain more than 13 parts per million of selenium. In these cases protection from the arsenicals will be even less complete.

When linseed oil meal is incorporated into the rations of white rats at a 20 percent level, it protects against selenium poisoning. The one trial with swine showed that at a more practical level (14 percent) this protein supplement was effective in reducing the symptoms of the poisoning. However, gains in weight were no better with the linseed oil meal than with the soybean oil meal and feed efficiency was reduced. The data indicate that linseed oil meal is not necessarily the protein supplement of choice for rations for growing and fattening swine in seleniferous areas.

When a protein concentrate containing an organic arsenical and corn with added selenium were self-fed separately, the arsenical did protect against selenium poisoning. However, under these conditions the hogs ate less of the seleniferous grain and more of the supplement. This is not surprising, since it has long been known that animals given their choice prefer nontoxic feeds to those containing selenium. However, the hogs on seleniferous rations to which organic arsenicals had been directly added ate about as well as those on control rations. Thus it appears that if only seleniferous feed is offered, it will be eaten well provided the animals are protected against the poisoning.

Inclusion of chlortetracycline in seleniferous rations was of no value in preventing the poisoning. It did not, however, increase the severity of the symptoms. Furthermore, when the chlortetracycline was added along with an organic arsenical it apparently gave some growth stimulation, while the arsenical protected against the selenium.

Conclusions and Recommendations

The selenium content of grains in areas where this element is a problem is quite variable. The climate, type of grain, field in which it is grown, and several other factors all act to determine how much selenium the harvested grain will contain.

The swine grower in these areas cannot, therefore, know whether or not his feeds are toxic (or if they are, how toxic) without a continuous program of chemical analysis. In view of these conditions a practical feeding program should include control measures that can be used routinely on feeds of varying selenium contents and still make money for the grower.

Organic arsenicals are now being used as feed additives for the stimulation of the growth of swine on normal rations. Despite their failure to give complete protection against selenium poisoning, they are so obviously beneficial when incorporated into toxic rations that their use is to be recommended.

Furthermore, when used at the levels recommended, protection against selenium should be obtained when feeds are toxic, whereas growth stimulation is possible when feeds are not toxic. Thus the certainty of returns from the investment made in their purchase is good.

Recommendations

Recommendations for use of organic arsenicals in seleniferous rations for growing-fattening swine are as follows:

1. Incorporate arsanilic acid or sodium arsanilate into the ration at a level of 0.01 percent (90 grams per ton). Do not use at higher levels.
2. Incorporate 3-nitro-4-hydroxyphenylarsonic acid into the ration at a level of 0.005 percent (45 grams per ton). (This level is above that generally recommended for growth stimulation in swine.) Do not exceed the 0.005 percent level.
3. Use either of the arsenicals listed. Mix it well with the total ration. Do not feed in a supplement separate from the seleniferous grains. Begin feeding the arsenical at weaning and continue until hogs weigh at least 125 to 150 pounds. When used throughout the fattening period, remove feeds containing organic arsenical 5 to 10 days before marketing. (This eliminates arsenic from the tissues.)
4. Since feeding organic arsenicals is not a completely effective control against selenium poisoning, use other practices to aid in the control. Mix grains from two or more fields. (This reduces the possibility that a ration will contain exceptionally high amounts of selenium.) Use grains from fields known to produce crops of exceptionally high selenium content as a small portion of the total ration, if at all.

Precautions

Precautions in the use of organic arsenicals for swine on seleniferous rations are as follows:

1. Follow carefully the recommendations listed—organic arsenicals are toxic at higher levels of feeding. Use caution in handling these chemicals in the pure form. After they have been mixed with feed (or as purchased in commercial supplements), they are so diluted as to no longer be hazardous.
2. Do not expect organic arsenicals to make up for feed deficiencies. Be sure to use balanced rations for good results.

These findings and recommendations apply only to growing-fattening hogs on seleniferous rations. More experimental work will be needed to determine the place of organic arsenicals in the rations of breeding swine.

Work published elsewhere (*Poultry Science* 33:768, 1954) has demonstrated that these same recommendations apply to poultry. It is not known whether these organic arsenicals are effective against selenium poisoning in cattle. Until experimental work now under way can be completed, the use of arsanilic acid and 3-nitro for cattle in seleniferous areas cannot be recommended.