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EXCRETION OF A SINGLE DOSE OF SELENIUM IN SHEEP*)

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Selenium is excreted mainly via the respiratory tract, urine, and feces (*Rosenfeld* 1964). In cats, rabbits, and rats the main route for the elimination of selenium is in the urine (*Smith et al.* 1937, 1938; *McConnell* 1941).

In sheep, *Cousins & Cairney* (1961) reported that the major pathway for elimination of selenium was via the feces. Fecal excretion was some three to four times as great as urinary excretion, whether the intake of the element was in the form of organic feed selenium or of inorganic sodium selenite. *Butler & Peterson* (1961) introduced selenium as Se^{75}-selenious acid into the rumens of sheep and recovered 51 per cent in feces over a 72-hour period. These authors therefore consider that the major route for excretion of selenium in ruminants is not via the urine as in monogastric animals but via the feces. *Rosenfeld & Eppson* (1964), on the other hand, found that in sheep the Se^{75}-excretion in urine exceeded that in the feces when Se^{75} was administered orally.

Smith et al. (1938) reported that in cats and rabbits relatively less selenium was eliminated in the urine of animals receiving naturally occurring feed selenium than in those receiving sodium selenite or selenate. Fecal excretion was on the same level with both organic and inorganic compounds. *Moxon et al.* (1941)

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found, however, no significant difference in the amount of selenium excreted by rats receiving seleniferous wheat, selenocystine, or sodium selenite.

It has been shown that rats exhale between 17 and 52 per cent of an injected subcutaneous dose of selenium as selenite within 8 to 10 hours (*Schultz & Lewis* 1940; *Ganther & Baumann* 1962). But as the level of injected selenium is decreased, the percentage exhaled falls rapidly (*Olson et al.* 1963). As far as can be found, no studies have been made on respiratory elimination of selenium by sheep given injections of tracer or therapeutic doses of this substance.

The present investigation was undertaken to study the excretion of selenium and how the dose level and route of administration influence this excretion.

MATERIAL AND METHODS

Se^{75}-sodium selenite and Se^{75}(L)-selenomethionine were obtained in aqueous solution from The Radiochemical Centre, Amersham, England. Non-radioactive sodium selenite was added to the Se^{75}-sodium-selenite solution in those cases in which the highest doses were given. Non-radioactive (DL)-selenomethionine from Calbiochem, Los Angeles, USA was added to the Se^{75}(L)-selenomethionine in order to raise the concentration of selenomethionine.

Se^{75}(L)-selenocystine was obtained as powder from Farbwerke Hoechst AG, Germany. The powder was dissolved in 0.1 N-HCl.

The sheep were of Swedish "lantras" type. Their ages ranged from 7 months to 10 years. They weighed between 22 and 62 kg. In the account of the Se^{75}-concentrations in plasma and whole blood under "Results" the values obtained for each animal have been recalculated so as to correspond with a standard weight of 40 kg. During the experiments the animals received conventional fodder of hay, straw, grain, and wheat bran.

The excretion of Se^{75} in feces and urine was studied in 30 sheep. The selenium doses per kg mean weight, routes of administration, type of selenium compound administered, mean weight, and number of animals of each sex are shown in Table 1. The radioactive dose of selenium varied between 30 μC and 540 μC of Se^{75} per animal. The total dose of selenium was equally high for all the animals in each series, irrespective of body-weight, except in the series in which 0.13 mg of Se per kg mean weight was given intraruminally, the biggest sheep receiving 6.4 mg and the rest 5.1 mg of Se.

After injection of the respective solutions, feces and urine were collected for 7 and 13 days. The ewes were placed in a box designed to allow collection of feces and urine separately (*Ekman* 1961). The rams were fitted up with rubber bags from which the urine was drawn into collecting vessels. The latter were emptied at intervals as indicated

in Figs. 3 a, b and c. The amounts of feces and urine were measured. About 20 g of feces from each sample were finely ground and approximately 1 g was weighed out for measurement of the amount of radioactive selenium. Blood samples were taken from the jugular veins at intervals as indicated in Figs. 1 and 2.

Biliary fistulas were established in 2 ewes by the method of *Markowitz et al.* (1959). In one of them the bile was drained through a polyethylene catheter from the common duct. In the other one the common duct was ligated and the bile was drained through a polyethylene catheter from the gallbladder. The animals were given injections of Se^{75}-sodium-selenite solution subcutaneously. The dose was 0.14 mg of Se per kg mean weight. The animals weighed 32 kg and 42 kg, respectively. After the injection bile was collected over a 48-hour period; the animals were then killed and the gallbladders were emptied. The collecting vessels were emptied every 3 to 12 hours and the amounts of bile were measured.

The excretion of Se^{75} via the expired air was studied in 5 sheep. They weighed between 24 and 53 kg with a mean weight of 40 kg. After injection of Se^{75}-sodium selenite in a dose of 0.13 mg of selenium per kg mean weight, 3 sheep were placed in a respiration chamber (*Holtenius* 1957) for 12—24 hours. In the chamber the temperature was 15.0 ± 0.2°C and the relative humidity of the air 45—65 %. Before the injection of selenium tracheotomy had been performed in 2 sheep and they were intubated with a "Bassett cuffed tracheostomy tube"*). The current of air drawn through the chamber, 20 l per minute, was passed through three tubes containing concentrated H_2SO_4, 8 N-HNO_3, and 6 % $Hg(NO_3)_2$-solution in 3 N-HNO_3, respectively, for collection of the selenium. From the tracheotomized animals the expired air was passed through two tubes containing 6 % $Hg(NO_3)_2$-solution over a 24-hour period. The amounts of solution in the tubes were measured after 6 hours and/or at the end of the experiments.

The radioactivity was measured with a well-type scintillation detector connected to a single-channel analyzer and a scaler or in an auto-gamma spectrometer. The measurements were made on specimens of about 1 g of feces and 1.0 ml or 2.0 ml of urine, plasma, whole blood, bile, or absorption solution.

The excretion data at 7 days were analysed statistically using Student's t-test.

RESULTS

The concentration of Se^{75} in the blood rose very rapidly after subcutaneous injection of Se^{75}-sodium selenite (Figs. 1 a, b and c) and reached its maximum value after 1 hour with the two higher doses (Figs. 1 a and b) and after 8 hours with the lowest dose (Fig. 1 c). Then it fell rapidly during 48 hours with all three

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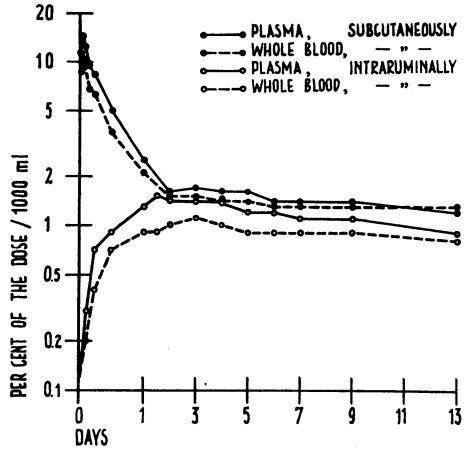
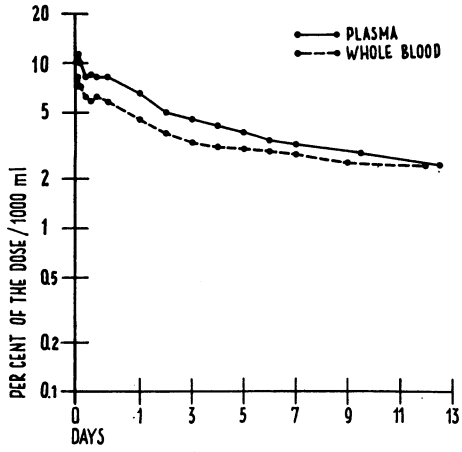


Figure 1 a. Se^{75}-concentration in plasma and whole blood in sheep after subcutaneous and intraruminal injection of 0.13 mg of Se per kg as Se^{75}-sodium selenite. Each curve represents the mean values for 5 animals. The values correspond with a standard body-weight of 40 kg.



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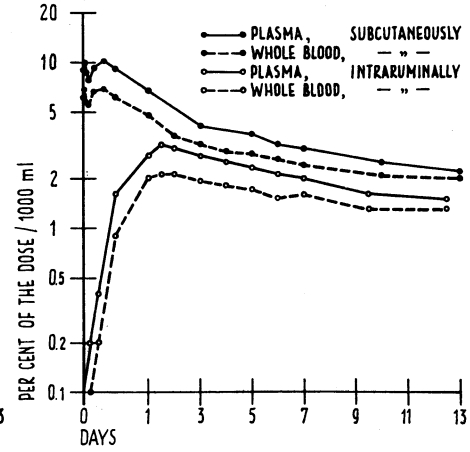


1 c.

Figure 1 b. Se^{75}-concentration in plasma and whole blood in sheep after subcutaneous injection of 0.01 mg of Se per kg as Se^{75}-sodium selenite. Each curve represents the mean values for 8 animals. The values correspond with a standard body-weight of 40 kg.

Figure 1 c. Se^{75}-concentration in plasma and whole blood in sheep after subcutaneous and intraruminal injection of 0.003 mg and 0.002 mg, respectively, of Se per kg as Se^{75}-sodium selenite. The curves represent the mean values for 2 animals after subcutaneous and for 4 animals after intraruminal injection. The values correspond with a standard body-weight of 40 kg.

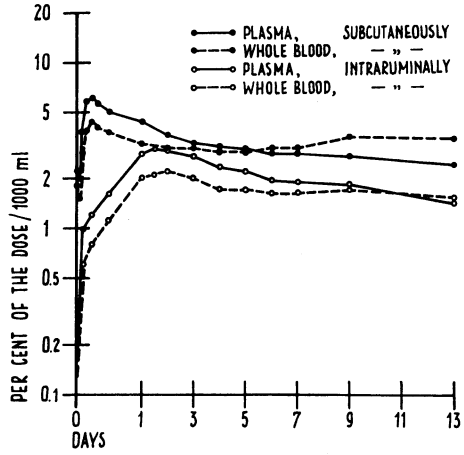


Figure 2. Se^{75}-concentration in plasma and whole blood in sheep after subcutaneous and intraruminal injection of 0.005 mg and 0.006 mg, respectively, of Se per kg as Se^{75}-methionine. The curves represent the mean values for 2 animals after intraruminal administration and for 2 animals during the first 7 days and one animal during 7—13 days after subcutaneous injection. The values correspond with a standard body-weight of 40 kg.

doses. Over the next 11 days it fell very slightly. After intraruminal administration the Se^{75}-concentration of the blood rose in the first two 24-hour periods, reaching approximately the same level as after subcutaneous injection of an equally large dose (Figs. 1 a and c).

When Se^{75}-selenomethionine was injected subcutaneously, the Se^{75}-concentration of the blood rose rapidly, reaching its maximum value after 6 hours. During the next 48 hours it fell to approximately 50 per cent of the maximum value (Fig. 2). After intraruminal administration the Se^{75}-concentration of the blood rose in the first 48 hours to approximately the same level as that reached within 48 hours of subcutaneous injection (Fig. 2).

The excretion of Se^{75} via the urine was significantly higher than that via the feces after subcutaneous injection of 0.13 mg and 0.01 mg of Se per kg ($P < 0.001$). More than half the excretion in the urine occurred in the first 24 hours after subcutaneous injection (Table 1). After 24 hours the Se^{75}-concentration decreased rapidly both in the urine and in the feces, and after a week it was very low (Fig. 3 a). A significantly greater proportion of the Se^{75}-dose ($P < 0.001$) was excreted in the

Table 1. Urinary and fecal excretion of selenium in sheep.

Route of administration, dose and type of selenium compound used	Mean body weight kg (Number of animals in the series)	Time in days	Per cent of dose in Urine F[1]	M[2]	$\bar{x}$	s	Feces F[1]	M[2]	$\bar{x}$	s
Subcutaneous	29	1	1	1	7.7	—	1	1	2.4	—
0.003 mg	(2)	2	1	1	9.1	—	1	1	3.6	—
Se/kg, Na_2SeO_3		7	1	1	10.9	—	1	1	8.9	—
		13	—	1	12.8	—	—	1	10.8	—
Subcutaneous	45	1	5	2[3]	25.0	5.8	5	3	2.0	0.8
0.01 mg	(8)	2	5	2	27.5	5.8	5	3	3.8	1.0
Se/kg,		7	5	2	29.8	5.6	5	3	7.3	1.4
Na_2SeO_3		13	—	1	31.0	—	—	2	11.0	—
Subcutaneous	38	1	5	—	33.7	5.3	5	—	3.2	1.2
0.13 mg	(5)	2	5	—	44.2	3.8	5	—	6.5	1.8
Se/kg,		7	5	—	49.6	3.4	5	—	10.2	2.3
Na_2SeO_3		13	2	—	52.0	—	2	—	12.2	—
Subcutaneous	38	1	1	1	5.1	—	1	1	3.2	—
0.005 mg	(2)	2	1	1	5.6	—	1	1	5.0	—
Se/kg,		7	1	1	7.4	—	1	1	12.0	—
selenomethionine		13	—	1	11.3	—	—	1	16.8	—
Intravenous	53	1	1	1	8.4	—	1	1	1.6	—
1.06 mg	(2)	2	1	1	9.2	—	1	1	2.8	—
Se/kg,		7	1	1	11.2	—	1	1	7.0	—
selenocystine		13	—	1	15.8	—	—	1	9.3	—
Intraruminal	48	1	1	3	0.9	0.6	1	3	18.2	4.5
0.002 mg	(4)	2	1	3	1.4	0.8	1	3	41.4	6.9
Se/kg,		7	1	3	2.5	0.9	1	3	60.2	3.7
Na_2SeO_3		13	—	2	3.0	—	—	2	64.1	—
Intraruminal	38	1	5	—	6.8	1.8	5	—	11.3	2.9
0.13 mg	(5)	2	5	—	13.3	1.3	5	—	30.6	7.9
Se/kg,		7	5	—	18.6	1.4	5	—	53.9	7.5
Na_2SeO_3		13	3	—	18.3	—	3	—	57.6	—
Intraruminal	30	1	—	2	1.4	—	—	2	19.9	—
0.006 mg	(2)	2	—	2	2.1	—	—	2	42.6	—
Se/kg,		7	—	2	3.2	—	—	2	58.2	—
selenomethionine		13	—	—	—	—	—	—	—	—

F[1]) = number of females.

M[2]) = number of males.

[3]) This series contained 3 rams, but one had to be excluded because of an accident with the urine samples.

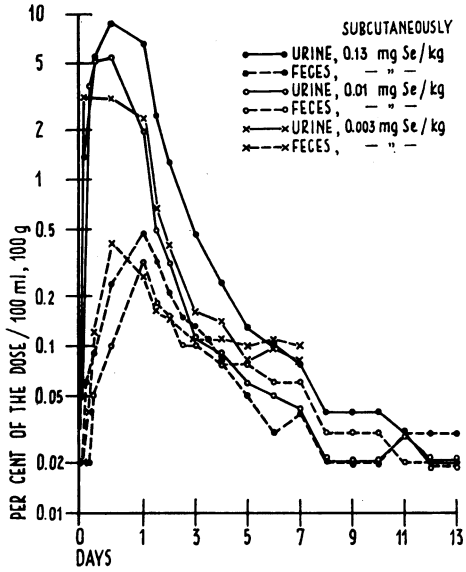
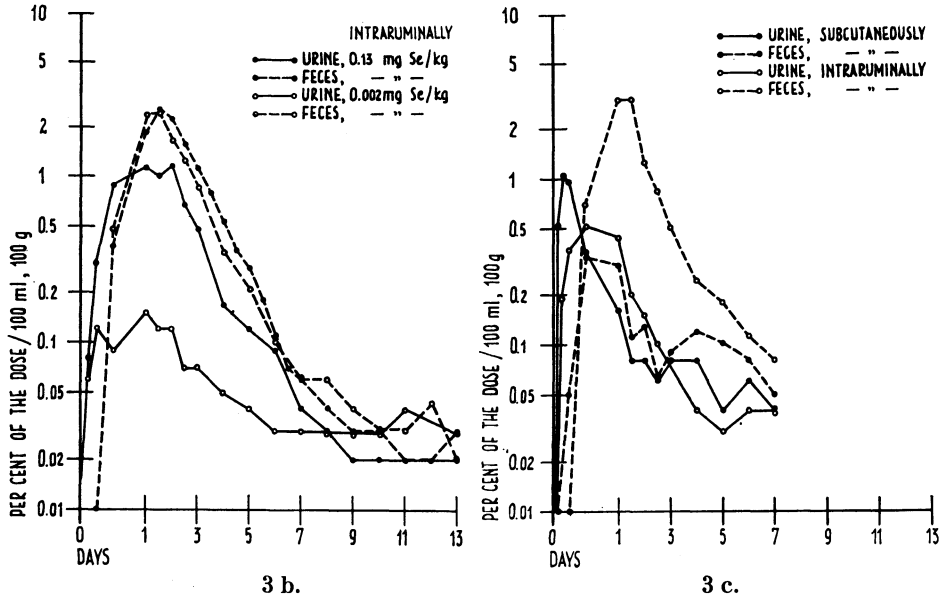


Figure 3 a. Se^{75}-concentration in urine and feces of sheep after subcutaneous injection of 0.003 mg, 0.01 mg, and 0.13 mg of Se per kg as Se^{75}-sodium selenite. The curves represent the mean values for 5 animals after the 0.13-mg dose and for 2 animals after the 0.003-mg dose. For the 0.01-mg dose the curves represent the mean values for 8 animals during the first 7 days and for 2 during 8—13 days.

urine after 0.13 mg than after 0.01 mg of selenium per kg bodyweight. The proportion of administered Se^{75} excreted via the feces was significantly greater ($P < 0.05$) after 0.13 mg than after 0.01 mg of selenium per kg subcutaneously (Table 1). After the highest subcutaneous dose, which is equivalent to a therapeutic dose, fecal and urinary excretion during 7 days averaged 59.8 per cent and during 13 days 64.2 per cent.

After intraruminal injection of selenium the excretion via the feces was significantly higher ($P < 0.001$) than that via the urine, irrespectively of the dose level (Table 1). The proportion of the dose eliminated via the urine was significantly greater ($P < 0.001$) after the higher than after the lower dose (Table 1; Fig. 3 b). There was no significant difference in the fecal excretion between the two doses. The Se^{75}-concentrations in the feces rose to maximal values in the first 48 hours after intraruminal administration. Then they fell and on the 9th day they were down to about 1 per cent of the maximal value (Fig. 3 b). The urinary concentrations also reached maximal values in the first



3 b. 3 c.

Figure 3 b. Se^{75}-concentration in urine and feces of sheep after intraruminal injection of 0.002 mg and 0.13 mg of Se per kg as Se^{75}-sodium selenite. The curves represent the mean values for 5 animals after the 0.13-mg dose. For the 0.002-mg dose the curves represent the mean values for 4 animals during the first 7 days, for 3 animals during 7—10 days, and for 2 animals during 10—13 days.

Figure 3 c. Se^{75}-concentration in urine and feces of sheep after subcutaneous and intraruminal injection of Se^{75}-methionine. Each curve represents the mean value for 2 animals. The subcutaneous dose was 0.005 mg and the intraruminal dose 0.006 mg of Se per kg body-weight.

48 hours. Thereafter they fell, remaining unchanged after 6 and 9 days, respectively. Of the highest intraruminal dose, which is equivalent to a therapeutic oral dose, 72.5 per cent were excreted within 7 days and 75.9 per cent within 13 days of the administration.

After injection of Se^{75}-selenomethionine subcutaneously and of Se^{75}-selenocystine intravenously the animals excreted approximately equally large proportions of the doses as after the lowest subcutaneous dose of Se^{75}-sodium selenite (Table 1; Fig. 3 c).

After intraruminal administration of Se^{75}-selenomethionine the fecal and the urinary excretion of Se^{75} equalled that after the lowest intraruminal dose of Se^{75}-sodium selenite (Table 1; Fig. 3 c).

The 48-hour biliary excretion in the two sheep amounted to 1.4 per cent and 3.7 per cent, respectively, of the administered doses.

From the current of air drawn through the respiration chamber 0.7 per cent of the dose was collected for 1 sheep during 12 hours and 0.8 per cent and 1.0 per cent for 2 sheep, respectively, during 24 hours. The two intubated sheep eliminated 1.2 per cent and 2.2 per cent, respectively, of the Se^{75}-dose via the respiratory tract.

DISCUSSION

The study shows that the route of administration and the dose of selenium determine whether the main pathway for the elimination of the element will be via the feces or via the urine.

When selenium was given to sheep by the intraruminal route, the main part of the dose was eliminated via the feces, whether the selenium was organic or inorganic in form. This agrees with the observations of *Cousins & Cairney* (1961) and *Butler & Peterson* (1961) after oral administration of selenium to sheep. According to these authors, the cause of the high fecal excretion would be that the ingested selenium is converted to a non-absorbable form. They also showed that most of the fecal selenium was present in insoluble form. *Butler & Peterson* report that approximately half the insoluble material was protein-bound and the other half inorganic. The insoluble inorganic material may possibly be elemental selenium, or selenite or selenide in heavy metal combination. *Peterson & Spedding* (1963) obtained similar results by feeding to sheep Se^{75} incorporated into red clover. They found that a small portion of the protein-incorporated fecal selenium was probably bacterial in origin.

Subcutaneous injection of Se^{75} gave higher Se^{75}-concentrations in plasma and higher percentage excretion in the urine than did intraruminal injection of an equally large dose. The urinary excretion of Se^{75} was also highest during the first few hours and days, when the plasma-Se^{75} level was highest. The amount of administered selenium bound to the plasma-proteins is not so great at that time as it is later. *Celander & Celander* (1965), in studies on dogs, showed that 6 hours after subcutaneous injection of Se^{75}-sodium selenite as much as 25 per cent of the dose could be removed by dialysis. At the end of an 8-day period none of the radioactive selenium was dialysable.

Moxon et al. (1941) found no significant difference in the amount of excreted selenium between rats receiving selenium-containing wheat, selenocystine, or sodium selenite. Nor do the investigations presented here show any distinct differences between Se^{75}-selenomethionine and Se^{75}-sodium selenite, either after subcutaneous or after intraruminal injection of tracer doses. It should be noted that injection of Se^{75}-selenocystine meant a high selenium dose because of low specific radioactivity. It was also necessary to use the intravenous route, since the powder had to be dissolved in acid. For these reasons, a comparison between the excretion of Se^{75}-sodium selenite and of Se^{75}-selenocystine would be somewhat fallacious. On the other hand, the results could suggest that the elimination of Se^{75}-selenocystine was not as high as that of Se^{75}-sodium selenite. If so, they would agree with the result obtained by *Smith et al.* (1938) showing greater retention of organic than of inorganic selenium.

On the whole, the obtained results of biliary excretion, 1.4 per cent and 3.7 per cent, agree with the values of 1.70 per cent and 2.56 per cent, reported by *McConnell & Martin* (1952) in a dog. It is possible that the higher percentage excretion, 13.9 per cent, reported by *Rosenfeld & Eppson* (1964) in sheep may be that they used higher and repeated doses of selenium. In the present study the sheep eliminated 6.5 ± 1.8 per cent ($\bar{x} \pm s$) in the feces during 48 hours and less than 3.7 per cent of the dose in the bile over the same period of time. This indicates that selenium enters the digestive tract along pathways other than via the bile.

The sheep studied in the present investigation exhaled between 0.7 and 2.2 per cent of the subcutaneous dose in 12 to 24 hours. This is much less than the percentages reported by *Schultz & Lewis* (1940), *McConnell* (1942) and *Petersen et al.* (1951). *Olson et al.* (1963) found, however, that when the dose was reduced, there was a rapid fall in the percentage of selenium eliminated via the expired air. After a dose of 0.4 mg of selenium per kg body-weight these authors found that the rats exhaled 1.9 to 2.8 per cent of the administered dose during 6 hours. This agrees with the results obtained in the present work, in which a low dose of selenium was also used.

The present results indicate that the percentage excretion increases with increasing selenium doses, both after subcutaneous and after intraruminal injection. The increase is due mainly to

greater excretion in the urine. The amount excreted via the feces did not depend upon the dose to the same degree as did that excreted via the urine. Only when the selenium dose was increased from 0.01 to 0.13 mg per kg body-weight, there was an increase in the percentage excreted via the feces. *Wright & Bell* (1964) also observed that a selenium supplement to the basic feed caused a significant rise in the percentage excretion of an oral dose of Se^{75} as selenious acid. The relatively greatest rise in excretion occurred when the subcutaneous dose was increased from 0.003 mg to 0.01 mg of selenium per kg. These results are in agreement with *Lindberg & Lannek*'s (1965) conclusions for swine, namely that when the physiological stores are filled a smaller proportion of the administered selenium will be retained. That is why these authors consider that a close comparison of different results is hazardous when the selenium concentration of the basal food is not known. The discrepancy between *Rosenfeld & Eppson*'s results and those obtained by, for instance, *Cousins & Cairney* and *Butler & Peterson* can probably be explained by the higher and repeated doses used by the first-named authors.

The present results indicate that it is difficult to establish the exact proportion of a single therapeutic dose that will be excreted, as this depends upon the selenium stores of the treated animal. In the experiments reported here approximately 64 per cent of a subcutaneous and 75 per cent of an intraruminal therapeutic dose were excreted in 2 weeks.

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SUMMARY

The excretion of Se^{75} via the feces and urine was studied in 30 sheep. Se^{75}-sodium selenite was injected subcutaneously, using three different doses ranging from a tracer dose to a therapeutic dose. By the intraruminal route the substance was given in a tracer dose and a therapeutic dose. Se^{75}-selenomethionine was injected subcutaneously and intraruminally in a tracer dose. Se^{75}-selenocystine was given intravenously in a dose higher than that regarded as a therapeutic dose.

After intraruminal injection a higher percentage of the dose was excreted via the feces than via the urine. After the two highest subcutaneous doses the urinary excretion was significantly higher than the fecal excretion. After a high selenium dose the percentage eliminated via the urine was greater than after a low dose, whether the subcutaneous or the intraruminal route was used.

The fecal and urinary excretion of Se^{75} was of approximately the same order after injection of Se^{75}-selenomethionine and Se^{75}-selenocystine as after injection of the tracer dose of Se^{75}-sodium selenite.

In 2 sheep, 1.4 per cent and 3.7 per cent, respectively, of a therapeutic dose were excreted via the bile in 48 hours.

Less than 3 per cent of a subcutaneous dose was eliminated with the expired air in 24 hours.

Exactly how much of a therapeutic dose is excreted within, for instance, 2 weeks is difficult to establish, as the treated animal's selenium supply with the feed is not known. In the experiments reported here, however, approximately 64 per cent of a subcutaneous and 75 per cent of an intraruminal therapeutic dose were excreted over a two-week period.

ZUSAMMENFASSUNG

Ausscheidung einer einzelnen Selendosis beim Schaf.

Die Ausscheidung von Se^{75} mit dem Kot und Harn wurde bei dreissig Schafen untersucht. Se^{75}-Natriumselenit wurde subkutan in drei verschiedenen Dosen injiziert, von der Spurdosis bis zur therapeutischen Dosis. Intraruminal wurde diese Substanz in zwei Dosen, in der Spurdosis und in der therapeutischen Dosis, injiziert. Se^{75}-Selenmethionin wurde subkutan und intraruminal in der Spurdosis injiziert. Se^{75}-Selencystin wurde intravenös in einer Dosis injiziert, die die als eine therapeutische Dosis angesehene Quantität übertraf.

Bei intraruminaler Injektion wurde mit dem Kot ein signifikant grösserer Teil der Dosis als mit dem Harn ausgeschieden. Bei den beiden höchsten, subkutan gegebenen Dosen war die Ausscheidung mit dem Harn dagegen signifikant grösser als mit dem Kot. Ein grösserer Teil der Dosis ging mit dem Harn bei einer höheren Selendosis als bei einer niedrigen, und zwar sowohl nach subkutaner als auch nach intraruminaler Injektion, ab.

Die Ausscheidung von Se^{75} mit dem Kot und Harn war nach der Injektion von Se^{75}-Selenmethionin und Se^{75}-Selencystin approximativ

von demselben Umfang wie nach der Injektion der Spurdosis von Se^{75}-Natriumselenit.

Bei zwei Schafen gingen mit der Galle während der Zeit von 48 Stunden 1,4 bzw. 3,7 % einer therapeutischen Dosis ab.

Mit der Ausatmungsluft wurden in 24 Stunden weniger als 3 % einer subkutanen therapeutischen Dosis ausgeschieden.

Die beispielsweise in zwei Wochen ausgeschiedene Menge einer therapeutischen Dosis ist schwer genau anzugeben, da die Selenzufuhr mit dem Futter bei dem behandelten Tiere unbekannt ist. In den vorliegenden Versuchen wurden jedoch in zwei Wochen 64 % einer subkutanen und 75 % einer intraruminalen therapeutischen Dosis ausgeschieden.

SAMMANFATTNING

Utsöndring av en enstaka selendos hos får.

Utsöndringen av Se^{75} med träck och urin undersöktes hos trettio får. Se^{75}-natriumselenit injicerades subkutant i tre olika doser; från spårdos till terapeutisk dos. Intraruminalt injicerades denna substans i två doser; spårdos och terapeutisk dos. Se^{75}-selenmetionin injicerades subkutant och intraruminalt i spårdos. Se^{75}-selencystin injicerades intravenöst i en dos större än vad som anses vara en terapeutisk dos.

Vid intraruminal injektion utsöndrades med träcken en signifikant större del av dosen än med urinen. Utsöndringen med urinen var däremot signifikant större än med träcken vid de båda högsta subkutana doserna. En större del av dosen avgick med urinen vid en hög selendos än vid en låg både vid subkutan och intraruminal injektion.

Utsöndringen av Se^{75} med träck och urin var av approximativt samma omfattning efter injektion av Se^{75}-selenmetionin och Se^{75}-selencystin som efter injektion av spårdosen Se^{75}-natriumselenit.

Med gallan avgick hos två får under två dygn 1,4 respektive 3,7 % av en terapeutisk dos.

Med utandningsluften avgick under ett dygn mindre än 3 % av en subkutan terapeutisk dos.

Exakt hur mycket av en terapeutisk dos, som utsöndras inom t. ex. två veckor, är svårt att ange, då det behandlade djurets selentillförsel med fodret ej är känd. I de föreliggande försöken utsöndrades emellertid under två veckor approximativt 64 % av en subkutan och 75 % av en intraruminal terapeutisk dos.

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