JOURNAL OF THE SCIENTIFIC AGRICULTURAL SOCIETY OF FINLAND
Maataloustieteellinen Aikakauskirja
Vol. 54: 113–118, 1982

Effects of dietary organic selenium content on fowls, chicks and eggs

ESA KÄÄNTEE, PAAVO KURKELA and KAARLO JAAKKOLA[1]

Food and Public Health Laboratory, SF-61800 Kauhajoki, Finland

[1] Kristiina Medical Centre, SF-64100 Kristiinankaupunki, Finland

Abstract. This study deals with the effects of dietary organic selenium on the condition of parent-fowls and offspring, on hatching and on egg Se, S, Fe, Zn and Cu contents.

The results showed that selenium contents of 0.14 to 0.85 mg/kg DM had no untoward effects on the condition of the animals or on hatching. The selenium contents of eggs and feed were interrelated. An increase in the selenium content of eggs caused no changes in their S, Fe, Zn or Cu contents.

Introduction

The use of fertilizers containing selenium leads to a substantial increase in selenium levels in plant-based diets, and also increases selenium concentrations in animals fed these diets. Fowls have been found to be extremely sensitive to selenium.

Selenium derived from foodstuffs has a stronger influence on selenium levels in fowls and eggs than corresponding amounts of sodium biselenite (KÄÄNTEE and KURKELA 1980). Marginally toxic amounts of selenium in the diet adversely affect the hatching of eggs (VOKAL-BOREK 1979). This study was carried out to investigate the effects of diets rich in selenium on parent birds, the hatching of eggs, and the offspring of birds fed such diets. The Se, Fe, Zn, Cu and S concentrations in eggs were also determined. Particular attention was paid to the possibility of malformations or teratogenic effects. This study is one of a series examining the effects on domestic animals of increases in organic selenium contents of diets as a result of use of fertilizers.

Material

The birds used in the study were 40 Leghorn hens, each of which was 20 weeks old, and 5 cocks. During the trial, the birds were kept in a 4 × 3 metre cage with a wooden floor, and equipped with laying nests, automatic drinking fountains and roosts. The animals were fed twice a day, using feeding troughs.

The diet consisted of a concentrate (Table 1), oats meal, poultry calcium and barley flour. The selenium content of the barley flour varied (Table 2). All the barley was grown in one field, various parts of which had been manured using fertilizers containing various amounts of selenium (KORKMAN 1980). Each barley flour was used in the diet for 3 weeks, starting with the flour with the lowest selenium content.

The cage floors were covered with peat litter.

Table 1

Composition of feed concentrate (air dry)	%
Skim milk powder	8.0
Fish meal flour	30.0
Soya grits	20.0
Food yeast	6.0
Bone meal (class I quality)	4.0
Meat and bone meal flour	10.0
Molasses	1.0
Powdered hay	7.4
Central Soyan ABDE -vitamin mixture	6.0
Food calcium	4.8
Calcium, Magnesium and Sodium Phosphates	0.8
Sodium Chloride	1.525
Magnesium Oxide	0.147
Copper Sulphate	0.023
Ferrous Sulphate	0.098
Potassium Iodide	0.001
Zinc Sulphide	0.106
Manganese Oxide	0.098
Cobalt Sulphate	0.002

Table 2. Selenium, iron, zinc, copper and sulphur concentrations of oats and barley in this study and concentrations of these elements in Finnish oats and barley according to VARO et al. (1980).

	Oats	Barley	Oats Varo et al.	Barley (1980)
Se	20	340–1400*	4–18	4–26
Fe	120	120–125	39–86	44–130
Zn	36	24–29	27–43	26–43
Cu	4.7	3.8–4.2	3.6–7.4	4.6–9.1
S	1.7	1.3–1.6	1.4–2.0	1.2–1.4

* Barley intended for use in the study diets was sprayed at the sprouting phase with solutions containing sodium selenite.

Methods

The hens and cocks were examined clinically twice a week. Eggs were collected daily. At the end of each 3-week feeding period, 6 eggs. were taken for laboratory examination and 12 eggs for incubation.

At the conclusion of the final feeding period, the cocks were decapitated and their livers, lungs, spleens, testes and hearts, together with samples of their neck muscles removed for laboratory examination.

Se, Fe, Zn, Cu and S concentrations in diet, egg and organ samples were determined in the Kemira Company Laboratory, Oulu, using the methods of SAARI and PAASO (1980).

The eggs were incubated at a temperature of 37.5 °C in an ordinary incubator, in which a shallow vessel of water had been placed. They were turned twice a day during incubation. The chicks and egg contents were investigated clinically after hatching. On the basis of these and earlier results (KÄÄNTEE and KURKELA 1980), correlations between dietary and egg selenium concentrations were assessed.

Results

The condition of the hens and cocks remained good throughout the trial. The Se, S, Fe, Zn and Cu concentrations of diets and eggs after each feeding period are shown in Table 3. The Se, Fe, Zn, Cu and S concentrations of the various organs removed from the cocks are shown in Table 5.

Thirty eggs were produced daily during the first trial period. During the second period, production remained unchanged but during the third period there was an increase to 38 eggs a day. During the fourth period, production decreased to 32 eggs daily.

The outcome of incubation, and numbers of dead chicks and nonfertile eggs are shown in Table 4.

All chicks hatched were found to be normal, well developed and healthy. Dead chicks were also normally developed.

The correlation between selenium concentrations in the diet and those in the eggs is shown in Fig. 1.

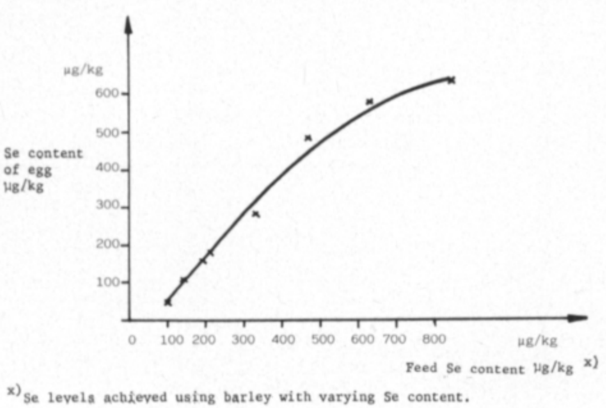

Figure 1. Relationship between dietary Se content and Se levels in eggs.

Table 3. Effects of dietary selenium, sulphur, iron, zinc and copper levels on the concentrations of these elements in whites of egg and egg yolks.

Dietary levels µg Se/kg DM		Egg yolk µg Se/kg fresh yolk	White of egg µg Se/kg fresh white	Whole egg µg Se/kg fresh contents
I	141	285 ± 90	30 ± 0	113 ± 25
II	212	450 ± 66	63 ± 23	180 ± 21
III	333	560 ± 51	142 ± 15	283 ± 14
IV	850	868 ± 79	540 ± 88	635 ± 55
g S/kg DM		g S/kg DM	g S/kg DM	g S/kg DM
I	3.4	4.03 ±0.16	18.8 ± 0.75	13.37 ± 0.19
II	36	4.05 ± 0.31	19.0 ± 0.63	13.70 ± 0.47
III	3.6	3.88 ± 0.25	17.83 ± 0.41	13.17 ± 0.38
IV	3.5	4.12 ± 0.24	16.83 ± 1.94	12.87 ± 1.49
mg Fe/kg DM		mg Fe/kg DM	mg Fe/kg DM	mg Fe/kg DM
I	260	157 ± 10	5.4 ± 2.8	57 ± 3.6
I	260	157 ± 10	5.4 ± 2.8	57 ± 3.6
II	215	135 ± 8	4.5 ± 1	48 ± 3
III	255	138 ± 8	6.8 ± 1.4	50 ± 3
IV	210	133 ± 5	7.5 ± 4	48 ± 4
mg Zn/kg DM		mg Zn/kg DM	mg Zn/kg DM	mg Zn/kg DM
I	100	86 ± 7	0.7 ± 0.3	29 ± 3
II	95	83 ± 10	1.1 ± 0.6	29 ± 3
III	110	92 ± 3	0.43 ± 0.3	31 ± 0.3
IV	100	87 ± 2.6	2.2 ± 2.3	30 ± 1
mg Cu/kg DM		mg Cu/kg DM	mg Cu/kg DM	mg Cu/kg DM
I	14.5	2.5 ± 0.4	< 2	0.8 ± 0.2
II	16.8	3.1 ± 0.3	2.1 ± 0.4	2.5 ± 0.4
III	16.8	3.1 ± 0.2	1.3 ± 0.3	1.9 ± 0.2
IV	13.5	2.8 ± 0.4	1.7 ± 0.24	2.95 ± 0.15

Table 4. Hatching following each study period

Study period	Living chicks	Dead chicks	Nonfertile eggs
I	9	1	2
II	8	3	1
III	10	1	1
IV	8	2	2

Table 5. Selenium, iron, zinc, copper and sulphur concentrations (in DM) in organs removed from cocks.

ORGAN	µg Se/kg	mg Fe/kg	mg Zn/kg	mg Cu/kg	g S/kg
Liver	2100±750	560 ± 95	94 ±11	13±1	10.5±0.6
Lungs	1200±550	1050± 55	59 ± 4	< 5	10.7±0.5
Spleen	2600±790	700 ±175	86 ±13	< 5	11 ±0.8
Testis	2000±400	140 ± 30	82 ±22	< 5	8.7±0.3
Neck	1000±600	210 ± 55	175±22	6.5±0.9	10.5±1.0
Heart	1200±450	320 ±200	87 ±11	10.4±1.3	9.5±0.6

Discussion

The minimum dietary Se requirement for poultry is 0.03–0.1 mg Se per day. The reprided level is 0.15 mg/kg (VOKAL-BOREK1979). According to nutrient requirements of poultry (ANON 1971), the Se requirements of breeding hens are not known for certain but chicks required 0.1 mg Se in their diet per kg. The dietary Fe requirement of chicks is 80 mg/kg in foodstuff, the Zn requirement 50 mg/kg and the Cu requirement 4 mg/kg.

In this study, the dietary Se content was 0.14–0.85 mg/kg DM in the feed (Table 3). The minimum level was the same as the reprided level according to VOKAL-BOREK (1979) and the maximum level 6 times higher. The S, Fe, Zn annd Cu contents of feeds were above the minima required, but remained constant throughout.

Se content of eggs

The Se content of eggs produced after feeding with the diet lowest in Se (0.14 mg/kg DM in the feed) was 113 ± 25 µg/kg and was the same as that reported by MORRIS and OLSON (1970) for the Se content of eggs.

The highest Se content of eggs, 635 ± 55 µg/kg, was above the level in eggs from Se-rich areas in the USA (0.4–0.5 mg/kg DM) (UNDERWOOD, 1971).

The analytical results for Se contents of eggs in this study were in accordance with results from earlier studies (KÄÄNTEE and KURKELA 1980). On the basis of these results, a graph showing the effect of dietary selenium content on the selenium content of eggs was prepared (Fig. 1).

The S, Fe, Zn and Cu levels in eggs remained the same throughout. The levels were the same as those found by VARO et al. (1980). The variations in dietary Se content in the present study did not affect the levels of S, Fe, Zn and Cu.

The production of eggs was typical of that normal in hens.

Because only a small number of birds was used, it was not possible to draw more extensive conclusions regarding the effects of dietary selenium levels on egg production.

References

ANON, 1971. Nutrient Requirements of Poultry. National Academy of Sciences, Washington, 232 pp.

HOFFMANN, S., 1978. Über den Mangan, Nickel und Kupfergehalt in Hühnerorganen. Wiener Tierärztl.. Wschr. 65: 260.

KORKMAN, J., 1980. The effect of selenium fertilizers on the selenium content of barley, spring wheat and potatoes. J. Scient. Agric. Soc. Finl. 52: 495–504.

KÄÄNTEE, E. and KURKELA, P., 1980. Comparative effects of barley feed and sodium selenite on selenium levels in hen eggs and tissues. J. Scient. Agric. Sos. Finl. 52: 357–367.

NUURTAMO; M., VARO, P., SAARI, E. and KOIVISTOINEN, P., 1980. Mineral element composition of Finnish foods. V. Meat and meat products. Acta Agr. Scand. Suppl. 22: 57–87.

MORRIS, V. C. and OLSON, O. E., 1970. Selenium content of foods. J. Nutrition 100: 1383–1388.

SAARI, E., and PAASO, A., 1980. Mineral element composition of Finnish foods. II. analytical methods. Acta Agr. Scand. Suppl. 22: 15–25.

UNDERWOOD, E. J., 1971. Trace elements in human and animal nutrition, 3rd Ed. Academic Press, New York, pp. 323–368.

VARO, P., NUURTAMO, M., SAARI; E. and KOIVISTOINEN, P., 1980. Mineral element composition of Finnish foods. VIII. Dairy products, eggs and margarine. Acta Agr. Scand. Suppl. 22: 115–126.

VOKAL-BOREK, H., 1979. Selenium. University of Stockholm, Institute of Physics. Report 79–16.

WU, S. H., OLDFIELD, J. E., MUTH, O. H., WHANGER, P. D. and WESWIG, P. H., 1973. Effect of selenium, vitamin E and antioxidants on testicular function in rats. Biol. Reprod. 8: 625–629.

Ms received May 14, 1982.

SELOSTUS

Rehun orgaanisen seleenipitoisuuden vaikutuksista kanojen ja kananpoikasten terveydentilaan sekä munien hedelmällisyyteen

Esa Kääntee
66270 Pörtom

Paavo Kurkela, Kauhajoen elintarvikelaboratorio,
61800 Kauhajoki

Kaarlo Jaakkola, Kristiinan lääkärikeskus,
64100 Kristiinankaupunki

Tutkimuksessa tarkastellaan rehun orgaanisen seleenin vaikutusta kanojen terveydentilaan, munien hedelmällisyyteen, poikasten terveydentilaan sekä munien Se-, S-, Fe, Zn- ja Cu-pitoisuuksiin.

Tutkimuksiin käytettiin 40 kanaa ja 5 kukkoa. Rehujen seleenipitoisuudet vaihtelivat välillä 0.14 mg/kg–0.85 mg/kg ka:ssa rehua.

Rehun S-pitoisuus oli 3.4–3.6 g/kg, Fe 210–260 mg/kg, Zn 95–110 mg/kg ja Cu 13.5–16.8 mg/kg.ka.

Kokeen aikana munien seleenipitoisuus kohosi 113 $\pm$25 µg/kg:sta 635 $\pm$55 µg/kg:n, mutta haudontatulos pysyi samana.

Kuoriutuneet poikaset olivat terveitä, normaalisti kehittyneitä ja elinvoimaisia.

Munien S-, Fe-, Zn- ja Cu-pitoisuudet pysyivät koko kokeen ajan samoilla tasoilla.

Tulokset osoittivat, ettei käytetyillä rehun seleenipitoisuuksilla ollut haitallisia vaikutuksia kanoihin eikä kananpoikiin.