EFFECT OF USING DIFFERENT LEVELS OF SELENIUM ON PRODUCTIVE PERFORMANCE OF WHITE HI-LINE LAYING HENS

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Abstract

The present study was designed to determine the effect of using different levels of selenium (Se) on the productive performance of White Hi-line laying hens. A total of 60 White Hi-line hens aged 16 weeks housed individually in cages (4 hens/cage) and divided into 3 equal groups was used. They were fed on the basal diet supplemented with 0 (as control group),5 and 10 ppm Se (as sodium selenate).The body weight, egg mass, feed consumption, feed conversion, egg quality measurements and some blood parameters were taken.Selenium concentration in some organs was determined.

Main results obtained can be summarized as follows:

-Supplementing the basal diet with 5 and 10 ppm Se caused significant decrease in body weight, egg number, egg mass and feed consumption.

-Shell weight, shell thickness and egg breaking strength were significantly decreased by supplementing the basal diet with 5 and 10 ppm Se.

-Hens fed on diets supplemented with 10ppm Se gave higher mortality rate than those of 0 and 5 ppm Se fed groups.

-The results obtained showed that the dietary Se supplementation caused significant increase in Se concentration of plasma,liver,kidney and muscles as compared to the control group.

-White Hi-line layer diet should not contain more than 5 ppm Se.

INTRODUCTION

Selenium (Se) plays an important role in the regulation of various metabolic processes in the body, being an integral part of selenoprotiens. Organic Se in the form of selenomethionine is a predominant form of this element in feed ingredients. Therefore, the digestive system of animals, including chickens, has been adapted to this form of the element during evolution. In this regard, selenite (a common form of Se used in diets) is not found naturally, and as a result, is less effective in terms of assimilation from the feed and building Se reserves in the body. Se toxicity is rare

event in poultry production. However, the precise Se requirement of various poultry species in commercial conditions needs further elucidation (Surai, 2002).

Selenium is recognized as having anti-carcinogenic and antiviral properties and is known to have important roles in reproductive function and development, immunocompetence and ageing. These Se functions have been described recently in series of comprehensive reviews (Brigelius-Flohe, 1999, Flohe *et al.*, 2000, Kohrle *et al.*, 2000, Arner and Holmgren, 2000, Holmgren, 2000, Schrauzer, 2000, Whanger, 2000).

The effect of different dietary Se sources and inclusion levels on egg Se concentration has been described by Cantor *et al.* (2000).

Selenium is toxic to poultry when used in high doses. However, it is necessary to stress that Se toxicity can usually only be seen when its dose exceeds the physiological requirement at least 10-fold. Data on this topic are sometimes contradictory, but, Se doses lower than 3-5 mg/kg feed are usually not associated with toxicity (Suria, 2002).

The minimum toxic dose of sodium selenate by the oral route was 0.9 mg/kg body weight for turkey poults, 1.7 for broiler chicks and 9.4 for ducks (Tishkov and Voitov, 1989).The toxic level from selenium for adult chickens was 5ppm(NRC,1994).

The present study was conducted to evaluate the performance of White Hi-Line laying hens when fed diets supplemented with 5 and 10 ppm Se.

MATERIALS AND METHODS

This experiment was carried out at Poultry Breeding Farm, Poultry Production Department, Faculty of Agriculture, Ain Shams University. A total of 60 White Hi-line pullets, aged 16 weeks, was used. These pullets were housed individually in cages (4 pullets/cage). They were divided into three equal groups fed the basal diet supplemented with 0 (as control group), 5 and 10 ppm Se (as sodium selenate). Experimental groups were reared under similar managerial, environmental and hygienic conditions. They were exposed to 16 hours photoperiod. The feed and water were provided ad libitum. The composition and calculated chemical analysis of the basal diet are shown in Table 1.

Measurements and observations

Individual body weights of laying hens were recorded at 4 weeks intervals. Likewise, egg mass and feed consumption were recorded. Also, feed conversion ratio was calculated.

At 34 weeks of age, an egg quality study was done for treated groups. A total of 150 eggs was collected from the treatments (50/ treatment). Each egg first weighed to the nearest 0.1g. The strength of eggshell was determined according to Fathi and El-Sahar (1996) using eggshell apparatus. The liquid contents of egg were put aside and shell plus membranes washed to remove adhering albumen. After drying, shells were weighed upon cooling to the nearest 0.01g. The thickness (mm) was measured using a dial gauge micrometer. The shell percent was calculated as the ratio of shell weight to egg weight multiplied by 100.

Table 1. The composition and calculated chemical analysis of the basal diet.

Ingredient	%
Yellow corn	61.80
Soybean meal 48%	19.30
Limestone	6.92
Glutfeed 16%	4.00
Corn gluten meal	2.90
Bone meal	2.45
Decorticated cotton seed meal	2.00
Salt	0.32
Vit -mineral mix*	0.25
DL-Methionine	0.04
L –Lysine	0.02
Total	100.00
Calculated chemical analysis:**	
Crude protein, %	17.91
Crude fat, %	3.0
Crude fibre, %	2.7
ME (kcal/kg)	2787
Calcium, %	3.31
Available Phosphorus, %	0.42
Lysine, %	0.87
Methionine, %	0.38
Methionine + cystine, %	0.68

* Each 2.5 Kg of Vit-mineral mix contain: Vit.A 12 m.I.U., Vit.D 4 m.I.U.,

Vit E 15 g ,Vit K_3 2 g ,Vit B_1 1g , B_2 8 g ,Vit B_6 2 g ,Vit B_{12} 10 mg ,Pantothenic acid 10 g, Nicotinic acid 30 g ,Folic acid 1 g ,Biotin 150 mg ,Choline chloride 600 mg , Copper 5 g ,Iodine 0.5 g ,Iron 15 g ,Manganese 70 g ,Zinc 60 g ,Selenium 0.15 g and Cobalt 0.15 g.

** By calculation according to (NRC, 1994).

At 34 weeks of age, a total of 30 blood samples (10 samples / treatment) was assigned for hematological assessment. A 3.0 ml blood sample was withdrawn from the brachial vein. A portion of the blood was used for hematocrit determination using capillary tubes and a microhematocrit centrifuge. The hematocrit figures were measured after spinning microhematocrit for 12 min. The resulting plasma was stored at –20°C for later analysis. The frozen plasma was allowed to thaw prior to analysis. Calcium , phosphorus, GOT and GPT were determined by enzymatic methods using available commercial kits SCLAVO INC., 5 Mansard Count., Wayne NJ07470, USA.The studied Se in the plasma and muscles were determined using Atomic Absorption Spectrophotometer 4100 ZL Perkin-Elmer.

Statistical analysis

Data were subjected to a one-way analysis of variance with treatment effect using the General Linear Model (GLM) procedure of SAS User's Guide, 1994.The statistical model used in this study was as follows:

$$Yij = \mu + Ti + eij$$

Where;

Yij=observed value

μ = overall mean

Ti = treatment effect

eij = experimental error

RESULTS AND DISCUSSION

Effect of dietary selenium supplementation on body weight

Body weights of laying hens as affected by dietary selenium supplementation are shown in Table 2. It could be noticed that the dietary selenium supplementation at 5 and 10-ppm had significant adverse effects on body weight of laying hens. However, the body weight of laying hens fed the diet contained 10-ppm Se was significantly decreased by about 9.6, 17.6 and 34.6% as compared to control-fed group at 22, 26 and 30 weeks of age, respectively. From this view, the 10-ppm Se treatment was

stopped at 30 weeks of age, then, the hens were fed a control diet. At 34 weeks of age, the body weight of 5-ppm Se-fed group was significantly lighter than that of control-fed group.

Table 2. Effect of dietary selenium supplementation on body weight of laying hens.

Age (wk)	Treatment		
	Control	5 ppm Se	10 ppm Se
18	1303.9	1302.3	1301.8
22	1475.8^{a}	1409.0^{b}	1333.85^{c}
26	1550.0^{a}	1465.0^{b}	1277.5^{c}
30	1591.0^{a}	1463.5^{b}	1041.0^{c}
34	1572.5^{a}	1449.3^{b}	

Means within rows with the same letters are not significantly different ($P<0.01$).

Effect of dietary selenium supplementation on egg production measurements

Effects of dietary selenium supplementation on egg number of laying hens are summarized in Table 3.

Results showed that the egg number of laying hens was not significantly affected by dietary selenium supplementation at 5-ppm from 18 to 28 weeks of age. However, the 10-ppm Se had significant adverse effect on egg number. Furthermore, the decreased of egg number for laying hens fed the diet contained 10 ppm Se gradually decreased with age, then, the laying hens were paused. Akulov *et al.* (1972) reported that egg production was unaffected by the lowest intake of Se in the feed, but, at intakes exceeding 0.8 mg/kg body weight it dropped from 64 to 8.7%, and at the heighest intake 6.4 or 9 mg/kg, egg laying ceased. Also, Ort and Latshaw, 1978, found that when Se as sodium selenate was added to the feed from 0.1 up to 9 mg/kg, egg production was decreased only by 9 mg/kg.

Egg weights of laying hens as affected by dietary selenium supplementation are shown in Table 4. It could be observed that, from 18 to 20 weeks of age, there was no significant difference among treated groups. Results showed that the dietary Se supplementation at 10 ppm significantly decreased egg weight of laying hens after 28 days of treatment, however, the effect of 5 ppm Se on egg weight was shown after

42 days of treatment. Ort and Latshaw (1978), found that egg weight was significantly decreased when Se was added to the diet by 7 mg/kg or higher.

Table 3. Effect of dietary selenium supplementation on egg number of laying hens.

Age (wk)	Treatment		
	Control	5 ppm Se	10 ppm Se
18-20	8.27	6.44	9.29
20-22	12.05	11.95	11.90
22-24	13.50[a]	13.95[a]	12.90[b]
24-26	13.55[a]	14.00[a]	12.00[b]
26-28	13.65[a]	13.20[a]	3.50[b]
28-30	12.30 [a]	10.75[b]	
30-32	13.20[a]	12.05b	
32-34	13.27	13.29	

Means within rows with the same letters are not significantly different ($p<0.01$).

Table 4. Effect of dietary selenium supplementation on egg weight of laying hens.

Age (wk)	Treatment		
	Control	5 ppm Se	10 ppm Se
18-20	41.97	42.07	41.16
20-22	47.21[a]	46.46[a]	43.35[b]
22-24	51.04[a]	49.68[b]	46.50[c]
24-26	54.19[a]	53.05[b]	49.28[c]
26-28	55.61[a]	53.36[b]	47.96[c]
28-30	55.98 [a]	52.58[b]	
30-32	56.52[a]	54.37[b]	
32-34	56.85	55.28b	

Means within rows with the same letters are not significantly different ($p<0.01$).

Egg mass, feed consumption and feed conversion ratio of laying hens as affected by dietary selenium supplementation are summarized in Table 5. It could be noticed that the control-fed group produced significant heavier egg mass from 18 to 22 weeks of age as compared to 5 and 10-ppm Se-fed groups.

From 22 to 26 weeks of age, the 10-ppm Se-fed group produced significant lighter egg mass as compared to control-fed group, however, there was no significant difference between 0 and 5-ppm Se-fed groups for egg mass.

From 26 to 34 weeks of age, it could be noticed that the control-fed group produced significant heavier egg mass as compared to 5 ppm Se-fed group.

With respect to feed consumption, results obtained showed that the control-fed group consumed significantly more feed as compared to 5 and 10 ppm Se-fed groups. It could be noticed that the dietary selenium supplementation at all levels significantly decreased the feed consumption as compared to laying hens fed the control diet. This finding could be attributed to the decreased body weight, and egg mass was nconsistent of hens fed the diet supplemented with 5 or 10 ppm Se as compared to ther fed a control diet.

Concerning the feed conversion ratio form 18 to 22 weeks of age, it could be noticed hat the 10 ppm Se-fed group had a lower feed conversion ratio as compared to control and 5 ppm Se-fed groups. Opposite trend was observed from 22 to 26 weeks of age, whereas, there was no significant difference between 5 and 10 ppm Se-fed groups for feed conversion ratio. However, the control-fed group had higher feed conversion ratio as compared to other groups.

From 26 to 30 weeks of age, result obtained showed that there was a significant difference between 0 and 5 ppm Se-fed groups for feed conversion ratio. Insignificant difference was noticed from 30 to 34 weeks of age.

Mortality rate of laying hens as affected by dietary selenium supplementation is illustrated in Fig 1. It could be noticed that the 10-ppm Se-fed group gave higher mortality rate than that of 0 and 5-ppm Se-fed groups, respectively. Todorovic *et al.* (1999) reported that feeding diets with 15, 20 and 30 mg Se/kg caused 26.7, 60 and 80% mortality, respectively.

Table 5. Effect of dietary selenium supplementation on egg mass, feed consumption and feed conversion ratio of laying hens.

Treatment			
Period (wk)	Control	5-ppm Se	10-ppm Se
Egg mass (g)			
18-22	914.92 a	828.61 b	896.34 b
22-26	1423.40 a	1435.75 a	1191.65 b
26-30	1447.6 a	1269.55 b	
30-34	1502.1 a	1393.31 b	
Feed consumption (g)			
18-22	2617.50 a	2373.00b	2206.50b
22-26	3157.00 a	2626.50b	2281.00b
26-30	3428.25 a	2901.95b	
30-34	3200.45 a	2923.50b	
Feed conversion ratio			
18-22	2.86 a	2.86a	2.46b
22-26	2.22a	1.83b	1.91b
26-30	2.37 a	2.29b	
30-34	2.13	2.10	

Means within rows with the same letters are not significantly different ($p<0.01$).

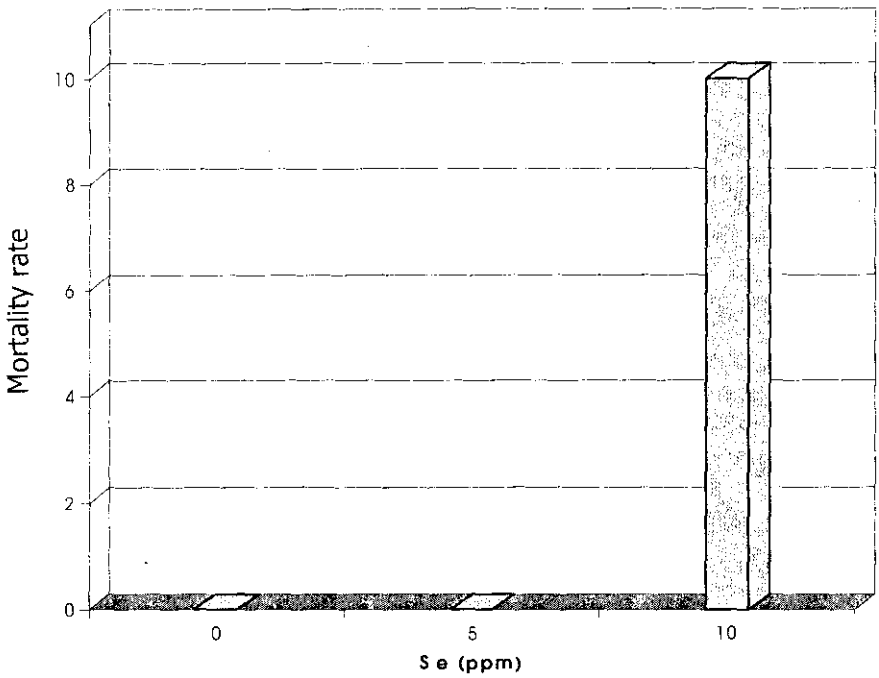

Fig.1. Effect of dietary selenium supplementation on mortality rate of laying hens.

Effect of dietary selenium on internal and eggshell quality

Internal and eggshell quality of laying hens at 26 weeks of age as affected by dietary selenium supplementation is presented in Table 6.

It could be noticed that the control-fed group gave significantly heavier egg weight as compared to 5 and 10-ppm Se-fed groups.

Results showed that internal and eggshell qualities of laying hens at 26 weeks of age were significantly affected by dietary selenium. It could be noticed that values of albumen weight, yolk weight, yolk %, shell weight and shell% of 5 and 10-ppm Se-fed groups were significantly lower than those of control-fed groups. Also, results showed that shell thickness, albumen height and yolk height of 5 and 10-ppm Se-fed groups were significantly less than control-fed group.

Table 6. Effect of dietary selenium supplementation on egg quality of laying hens at 26 weeks of age.

	Treatment		
Item	Control	5 ppm Se	10 ppm Se
Egg weight (g)	53.34^{a}	49.71^{b}	47.68^{c}
Albumen weight (g)	32.25^{a}	29.41^{b}	28.18^{b}
Albumen (%)	60.47	59.16	59.10
Yolk weight (g)	15.85^{a}	14.01^{b}	13.40^{c}
Yolk (%)	29.71^{a}	28.19^{b}	28.10^{b}
Albumen height (mm)	13.26^{a}	11.76^{b}	12.07^{b}
Yolk height (mm)	20.35^{a}	18.48^{b}	18.05^{b}
Yolk diameter (mm)	3.76	3.54	3.50
Shell weight (g)	5.24^{a}	4.48^{b}	4.24^{b}
Shell (%)	9.82^{a}	9.02^{b}	8.89^{b}
Shell thickness (mm)	0.38^{a}	0.30^{b}	0.29^{b}

Means within rows with the same letters are not significantly different ($p<0.01$).

Internal and eggshell qualities of laying hens at 34 weeks of age as affected by dietary selenium supplementation are presented in Table 7.

It could be noticed that egg weight, albumen weight, yolk weight of the control-fed groups were significantly heavier than those of 5 ppm Se-fed groups. Also, albumen height, yolk height, shell weight, seli % and shell thickness of control-fed group were significantly more than 5 ppm Se-fed group. Insignificant differences were found between the control and 5 ppm Se-fed groups in albumn%, yolk % and yolk diameter.

Table 7. Effect of dietary selenium supplementation on egg quality of laying hens at 34 weeks of age.

	Treatment	
Item	Control	5-ppm Se
Egg weight (g)	55.60 ^{a}	52.80^{b}
Albumen weight (g)	33.65 ^{a}	31.74^{b}
Albumen (%)	60.52	60.12
Yolk weight (g)	16.40 ^{a}	15.40^{b}
Yolk (%)	29.51	29.17
Albumen height (mm)	14.88^{a}	11.64^{b}
Yolk height (mm)	20.45^{a}	18.80^{b}
Yolk diameter (mm)	3.92	3.78
Shell weight (g)	5.54^{a}	5.05^{b}
Shell (%)	9.97^{a}	9.57^{b}
Shell thickness (mm)	0.39^{a}	0.31^{b}

Means within rows with the same letters are not significantly different ($p<0.01$).

Breaking strength of eggs as affected by dietary selenium supplementation is illustrated in Fig 2. At 26 weeks of age, results obtained indicated that the control-fed group had significantly higher breaking strength as compared to 5 and 10 ppm Se-fed groups.

At 34 weeks of age, it could be noticed that the control-fed group had significantly higher breaking strength as compared with 5 ppm Se-fed group.

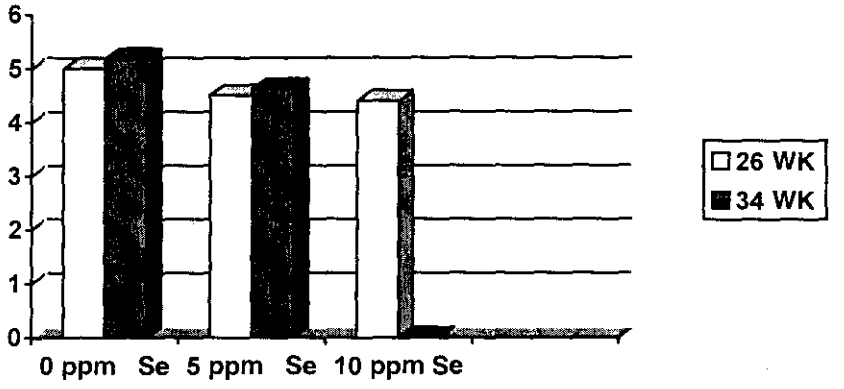

Fig.2. Effect of dietary selenium supplementation on breaking strength at 26 and 34 weeks of age.

Effect of dietary selenium on some organs of laying hens

Effects of dietary selenium supplementation on some organs of laying hens at 34 weeks of age are presented in Table 8. It could be noticed that the body weight of 5-ppm Se-fed group was significantly lighter than that of control-fed group.

Results showed that 5-ppm Se-fed group significantly increased liver weight, liver %, gizzard %, spleen weight and spleen % as compared to control-fed group, whereas, the differences between control and 5-ppm Se-fed groups in gizzard weight, heart weight and heart % were insignificant.

Table 8. Effect of dietary selenium supplementation on some organs of laying hens at 34 weeks of age.

	Treatment	
Item	Control	5 ppm Se
Live body weight (g)	1683.33 ^{a}	1583.33^{b}
Liver weight (g)	27.00 ^{b}	32.63^{a}
Liver (%)	1.58^{b}	2.06^{a}
Gizzard weight (g)	20.47	20.83
Gizzard (%)	1.22^{b}	1.32^{a}
Spleen weight (g)	1.40^{b}	1.87^{a}
Spleen (%)	0.08^{b}	0.12^{a}
Heart weight (g)	5.90	5.97
Heart (%)	0.35	0.38

Means within rows with the same letters are not significantly different ($p<0.01$).

Effect of dietary selenium supplementation on selenium concentration of some organs

Effect of dietary selenium supplementation on plasma, liver, kidney and muscles selenium concentration are presented in Table 9. The results obtained showed that the dietary selenium supplementation significantly increased the selenium concentrations of plasma, liver, kidney and muscles as compared to the control-fed group.

Table 9. Plasma, liver, kidney and muscles selenium concentration of hens fed dietary selenium.

Trait	Treatment	
	Control	5 ppm Se
Plasma	0.528^{b}	1.04^{a}
Liver	0.016^{b}	0.254^{a}
Kidney	0.019^{b}	0.146^{a}
Muscles	0.052^{b}	0.076^{a}

Means within rows with the same letters are not significantly different ($p<0.01$).

In conclusion, the results obtained showed that supplementing the layer diet with 5 ppm Se caused a significant decrease in body weight ,egg number ,egg mass ,feed consumption ,shell weight and shell thickness. More decrease occurs in these parameters when the layer diet was supplemented with 10 ppm Se. This decrease may be due to Se toxicity .Ort and Latshaw andNRC,1994 reported that the toxic level from Se was 5ppm for adult chickens .Therefore ,White Hi-line layer diet should not contain more than 5ppm Se.

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تأثير استخدام مستويات مختلفة من السيلينيوم على الأداء الإنتاجي للدجاج الهاي – لاين الأبيض البياض

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تهدف هذه الدراسة الى دراسة تأثير استخدام مستويات مختلفة من السيلينيوم على الأداء الإنتاجي للدجاج البياض .

تم استخدام ٦٠دجاجة هاى لاين أبيض عمر ١٦ أسبوعاً . وقد تم وضع٤ دجاجات فى كل قفص وقسمت الى ٣ مجاميع متساوية. وقد غذيت على عليقة أساسية مضافاً اليها السيلينيوم (فى صورة صوديوم سلينات) بمستويات صفر(مجموعة المقارنة) ١٠،٥ جزء فى المليون .تم أخذت قياسات وزن الجسم و وزن البيض و عدده و كتلة البيض والعلف المستهلك و حساب معامل التحويل الغذائى. وقد تم تقدير صفات جودة البيض و بعض قياسات الدم .كما تم تقدير تركيز السيلينيوم فى بعض الأعضاء.

و يمكن تلخيص أهم النتائج المتحصل عليها فيما يلى:

– إضافة السيلينيوم الى عليقة المقارنة بمستوى ١٠،٥ جزء فى المليون ينتج عنه انخفاض معنوى فى وزن الجسم و عدد البيض و كتلة البيض و معدل استهلاك العلف .

– ينتج عن إضافة السيلينيوم الى عليقة المقارنة انخفاض معنوى فى وزن و سمك قشرة البيضة و كذلك قوة تحمل القشرة للكسر.

– ارتفاع نسبة النفوق للدجاج الذى غذى على عليقة المقارنة مضافاً اليها السيلينيوم بمستوى ١٠ جزء فى المليون .

– أضافة السيلينيوم الى العليقة الأساسية للدجاج البياض أدى الى زيادة تركيز السيلينيوم فى بلازما الدم و الكبد والكلى والعضلات .

– يجب أن تحتوى عليقة الدجاج الهاى – لاين الابيض البياض على السيلينيوم بمستوى أقل من ٥ جزء فى المليون .

ومن هنا يتبين أن عليقة دجاج هاى – لاين لا يجب أن تحتوى على أكثر من ٥ جزء فى المليون من السيلينيوم .