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Alkane-grown yeast in relation to selenium in broiler diets

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Summary

In a trial, 1080 male white-leg (Hybro) chicks, 15 per cage, were given a basal diet low in selenium or diets with 12.5 or 25 % of G-yeast grown on alkane-type hydrocarbons. All diets were supplemented with 10 mg vitamin E and 100 mg antioxidant per kilogram and each kind of diet was supplemented with Se at 0.1, 0.25, 0.5, 0.75 and 1 mg/kg. There was a significantly negative linear effect of yeast on body weight, weight gain and a significantly positive linear effect on feed conversion up to 7 weeks of age, indicating that the two additions of G-yeast caused a depression in comparison with the control.

The supplements of selenium did not improve weight gain or feed conversion, but increased contents of Se in breast and leg muscle at 7 weeks. The contents of Se in muscles of the broilers on the basal diet were rather high, presumably because of carry-over from the hen via the egg.

Introduction

Numerous nutritional studies on selenium (Se) have shown that besides preventing dietary liver necrosis in rats and exudative diathesis in chicks deficient in vitamin E, Se is needed to prevent myopathy of the heart and skeletal muscles in calves and lambs, of the heart and gizzard muscles in turkeys, and to prevent atrophy and fibrosis of the pancreas in chicks. While most of these Se responsive nutritional diseases also respond to vitamin E, degeneration and fibrosis of the pancreas of the chick (Thompson & Scott, 1970) and hairlessness, poor growth and reproduction failure in rats (McCoy & Weswig, 1969) are prevented with as little as 0.1 mg of dietary Se per kg of diet, but not with vitamin E or any other known nutrient.

The studies on the nutritional and metabolic interrelationships of Se, vitamin E and sulphur amino acids in chicken nutrition were reviewed by Scott (1970). The level of available Se needed in the diet was reported by Scott & Thompson (1971), who showed it to depend upon the dietary content of vitamin E. With marginal levels of vitamin E, the available Se requirement of chicks is approximately 0.1 mg per kg of diet. As vitamin E increased, the Se requirement decreased; with 100 I.U. or more of vitamin E per kg of diet, the dietary Se requirement may be as low as 0.02 mg/kg of diet.

Osman & Latshaw (1976) worked with day-old chicks hatched from eggs laid by hens fed on a practical diet low in Se (about 0.07 mg/kg) and without added vitamin E. They reported that those chicks fed either sodium selenite or selenocystine showed a maximum response in weight gain and feed gain ratio at the lowest level, which was 10 μg Se per kg of diet. More Se from these compounds did not increase growth.

Scott et al (1976) reported that the Se level needed in practical diets for chickens should be about 0.15-0.20 mg/kg.

Scott & Thompson (1971) reported that Se accumulation in the blood, muscle, liver, kidney and skin bore a direct relationship to the inorganic Se content of the diet up to levels of about 0.2-0.3 mg/kg of diet. Increasing the dietary inorganic Se to 0.4, 0.6 or 0.8 mg/kg did not produce any appreciable increase in blood or muscle selenium in chickens of turkeys, compared with the diet contained a minimum level of 0.2-0.3 mg/kg.

Yeast have been used by people for millennia, primarily for production of alcoholic drinks and for making bread. Mixed cultures of yeast have been grown on gasoil (Miller & Johnson, 1966a) and N-paraffin (Miller & Johnson, 1966b). Yeast grown on normal paraffin oil is called G-type yeast and the product has been given the trade name Toprina.

G-type yeast has a protein content of 63 to 65 %, the contents of most of the essential amino acids are similar to those in other protein-rich products like fish meal; only the methionine and cystine contents of the yeast are lower than that of fish meal. The arginine content is distinctly lower than in soya bean oilmeal, whereas content of methionine plus cystine is not very different (Weerden et al., 1972).

The addition of yeasts grown on alkane-type hydrocarbons in broiler rations up to levels of 10-15 % have no adverse affect on performance (Shannon & McNab, 1972; Weerden et al., 1970 & 1972).

However when yeast is included in rations at levels of 20 % or more, some growth depression was noted (Shannon & McNab, 1972).

Finally Weerden et al. (1976) reported that the addition of 28 % G-yeast with or without selenium at 0.2 mg/kg caused a significant growth depression for broilers to 5 weeks of age in comparison with the control; growth with selenium was significantly better than without. They concluded also that the G-yeast addition in a pelleted feed was equivalent to the control diet of soya and fish meal.

The intention of this study was to test the relation between broiler performance and several levels of Se in the presence of vitamin E and antioxidant, and G-yeast.

Material and methods

A total of 1080 male broiler chickens, white-leg (Hybro) one-day-old from a commercial flock, were kept in batteries. 15 birds per cage in 4 replicants for each treatment. Each cage was supplied with a trough and a waterer and chicks were fed ad libitum.

The house was heated with two gas blower-heaters thermostatically controlled to recommended temperature and was continuously lit.

Chicks received a practical low-selenium basal broiler diet in a crumble form (Table 1 and 2), which had been specially formulated after analysing the feedstuffs for selenium.

Table 1. Composition of the standard low-selenium broiler diet and the G-yeast diets and their calculation (crembel).

Ingredients (%)	Selenium (mg/kg feedstuff analysed	Control	G-yeast 12.5 %	G-yeast 25 %
Maize, yellow	0.052	55.32	56.09	57.92
Soya meal (51.4 %)	0.083	25.00	16.00	5.00
Blood meal (83.7 %)	0.708	8.34	5.10	3.00
Yeast G (58 %)	0.10	–	12.50	25.00
Soya oil	0.00	6.70	5.70	4.50
$CaHPO_4 \cdot 2\ H_2O$[1]	0.00	2.10	1.85	1.70
Calcium carbonate[2]	0.00	1.05	1.30	1.45
Salt, iodized	0.00	0.40	0.40	0.40
Vitamin trace elements[3]	0.00	1.00	1.00	1.00
DL-methionine	0.00	0.09	0.06	0.03
Total	0.00	100.00	100.00	100.00
Calculated analysis				
Crude protein (N × 6.25) (%)		24.81	24.80	24.80
Metabolizable energy (MJ/kg)		13.97	13.96	13.97
Fat (%)		9.11	9.16	9.13
Crude fibre (%)		1.93	1.90	1.93
Ca (%)		1.01	1.01	1.01
P available (%)		0.52	0.50	0.51
Selenium (mg/kg)		0.10	0.09	0.08
Methionine (%)		0.47	0.47	0.47
Methionine + cystine (%)		0.87	0.85	0.82
Lysine (%)		1.62	1.58	1.60
Arginine (%)		1.58	1.69	1.78

[1] Chemically pure (23.3 % Ca, 19 % P).
[2] Chemically pure (Ca 40 %).
[3] The vitamin-mineral mixture supplied the following quantities per kg feed: vit. A 13 500 IU; vit. D_3 2250 IU; vit. E 10 mg; menadione 1.5 mg; vit. B_2 3.5 mg; niacin 40 mg; d-panthothenic acid 12 mg; choline chloride 800 mg; vit. B_{12} 0.01 mg $FeSO_4 \cdot 7H_2O$ 300 mg; MnO_2 100 mg; $CuSO_4 \cdot 5H_2O$ 100 mg; $ZnSO_4 \cdot 7H_2O$ 100 mg; antioxidant (Santoquin) 100 mg.

Table 2. The selenium addition[1] to the several rations.

Selenium additions mg/kg	Control		12.5 % G-yeast		25 % G-yeast	
	calculated	analysed	calculated	analysed	calculated	analysed
0.00	0.10	0.15	0.09	0.10	0.08	0.10
0.10	0.20	0.20	0.19	0.15	0.18	0.17
0.25	0.35	0.32	0.34	0.27	0.33	0.34
0.50	0.60	0.49	0.59	0.48	0.58	0.57
0.75	0.85	0.79	0.84	0.70	0.83	0.70
1.00	1.10	1.20	1.09	1.00	1.08	1.02

[1] Selenium was added in the form of sodium selenite ($Na_2SeO_3 \cdot 5H_2O$); average recovery 99 ± 5 %.

Treatments were a control (low Se) and G-yeast (extracted yeast grown on pure normal paraffins) at 12.5 and 25 % in diet; for each treatment there were 5 levels of Se in diet 0.10, 0.25, 0.50, 0.75 and 1.0 mg/kg. All diets contained 10 mg vitamin E and 100 mg antioxidant per kilogram feed.

Feed consumption and individual body weight of birds were estimated weekly, cumulative growth and feed conversion were calculated.

Selenium was determined in femoral and pectoral muscles of birds at 7 weeks of age by Nautron activation analysis according to Japenca et al. (1971).

Finally all the data were analysed for variance and were subjected to Student's *t* test (1975).

Results and discussion

The effect of 12.5 and 25 % G-yeast and the different levels of selenium on body weight, growth and feed consumption at 4 and 7 weeks of age is shown in Table 3. The three groups showed highly significant differences in body weight, growth and feed consumption at four and seven weeks of age and a clear negative highly significant trend with the linear component, indicating that the effect of 12.5 % G-yeast was less than the control and 25 % G-yeast was less than both. So high levels up to 12.5 % of G-yeast cause a significant depression of growth and less feed consumption.

In feed conversion too, there was a highly significant difference between the three groups. The control had the highest feed conversion followed by yeast at 12.5 % and then at 25 %, with a positive highly significant linear component. Our results are in agreement with those of Weerden et al. (1976) who reported that the addition of 28 % G-yeast with 0.2 mg/kg Se caused a significant growth depression and a high feed conversion in practical diets with fine (45 μm) yeast; in our case we used crumbles meal. According to Weerden pelleting improved the quality of the feed with 28 % G-yeast.

Table 3 shows also that the supplement of Se in several steps from 0.10 to 1.00 mg/kg in all three groups did not improve growth or feed conversion significantly at four or seven weeks of age, and did not improve the G-yeast quality.

Table 3. The effect of several G-yeast levels and several additions of selenium on body weight, growth, feed consumption and feed conversion.

Selenium addition (mg/kg)	Body-weight (g)		Growth (g) accumulative		Feed consumption (g) accumulative		Feed conversion	
	4 w	7 w	0-4 w	0-7 w	0-4 w	0-7 w	0-4 w	0-7 w
Control ration								
Control[1]	657.4	1603.7	618.0	1564.3	1011.1	2992.3	1.64	1.91
0.10	649.5	1597.3	610.5	1558.4	1031.6	3018.6	1.69	1.94
0.25	681.2	1640.0	641.6	1600.4	1041.5	3030.1	1.62	1.89
0.50	679.0	1642.1	639.6	1602.7	1064.5	3079.8	1.66	1.92
0.75	661.8	1591.7	621.6	1551.4	1039.0	3025.9	1.67	1.95
1.00	668.2	1638.0	628.2	1598.0	1043.5	3057.8	1.66	1.91
Mean	666.2	1618.8	626.6	1579.2	1038.5	3034.1	1.66	1.92
Ration with 12.5 % yeast								
Control[2]	664.7	1616.6	624.5	1576.5	1053.1	3031.3	1.69	1.92
0.10	638.6	1606.4	598.7	1566.5	1018.8	3023.3	1.70	1.93
0.25	637.8	1586.7	599.3	1548.2	1022.1	2956.9	1.70	1.91
0.50	632.7	1551.2	592.9	1511.4	1005.4	2928.4	1.70	1.94
0.75	645.4	1620.9	605.5	1580.9	1021.3	3035.2	1.69	1,92
1.00	635.7	1585.7	595.8	1545.8	1009.8	2976.3	1.69	1.93
Mean	642.5	1594.6	602.8	1554.9	1021.7	2991.9	1.69	1.93
Ration with 25 % yeast								
Control[3]	591.3	1509.7	552.3	1470.7	971.9	2863.2	1.76	1.95
0.10	577.2	1459.0	538.4	1420.2	964.3	2844.4	1.79	2.00
0.25	573.1	1476.6	534.2	1437.7	974.8	2867.3	1.82	1.99
0.50	577.7	1500.5	537.9	1460.6	964.0	2902.9	1.79	1.98
0.75	581.0	1511.8	541.4	1472.2	961.7	2858.4	1.78	1.94
1.00	573.8	1462.3	534.7	1423.1	986.5	2896.9	1.84	2.03
Mean	573.8	1462.3	539.8	1447.4	970.5	2872.2	1.80	1.98
F value D.F 30-2 (rations)	75.16**	54.62**	75.82**	54.64**	28.196**	13.775**	68.381**	14.852**
t linear component	−11.86**	−9.816**	−11.916**	−9.822**	−7.208**	−5.059**	11.268**	4.810**
t Quadratic component	−3.122**	−3.589**	−3.109**	−3.579**	−2.106*	−1.398	3.130**	2.563*
F value D.F 30-5 (selenium additions)	0.527	0.383	0.531	0.375	0.128	0.085	1.218	0.990
t linear component	−0.606	−0.134	−0.671	−0.167	0.152	0.470	1.403	1.028
t Quadratic component	0.374	0.283	0.346	0.267	0.208	0.252	−0.297	0.100

* $P < 0.05$; ** $P < 0.01$. [1] Control contains 0.10 mg/kg Se. [2] Control contains 0.09 mg/kg Se. [3] Control contains 0.08 mg/kg Se.

Table 4. Selenium content of muscles of male broilers on a wet basis.

Selenium addition mg/kg	Selenium content of muscles in (mg/kg)[2]	
	pectoral[3]	femoral[3]
Basal[1]	0.048 ± 0.0010	0.040 ± 0.0010
0.10	0.068 ± 0.0012	0.069 ± 0.0014
0.25	0.079 ± 0.0011	0.072 ± 0.0010
0.50	0.080 ± 0.0012	0.071 ± 0.0013
0.75	0.097 ± 0.0010	0.080 ± 0.0011
1.00	0.114 ± 0.0010	0.098 ± 0.0010
Mean	0.081	0.071

[1] Basal diet contained ca. 0.09 mg/kg selenium.
[2] Figures are means ± standard error.
[3] Average of individual analysis on 12 chickens of each treatment at 7 weeks of age.

It seems that Se is not needed in large amounts in the presence of vitamin E and antioxidant (Combs, 1978). Our results agree with the findings of Scott & Thompson (1971), who reported that as vitamin E increased, the selenium requirement decreased; with 100 IU or more of vitamin E per kg of diet the dietary Se requirement may be as low as 0.02 mg per kg of diet.

The Se content of breast and leg muscles of the broilers at 7 weeks of age was rather high with the basal diet (Table 4). It seems that the carryover of Se from the hens to their eggs and chicks played a role, and also the accumulation of Se low contents in the muscular tissue.

There was a clear increase in Se in breast and leg with the increase in dietary level from 0.10 to 1.00 mg/kg.

Our results disagree with those of Scott & Thompson (1971), who reported that increasing the dietary inorganic selenium to 0.4, 0.6 or 0.8 mg/kg did not produce any appreciable increase in selenium in blood or muscle of chickens or turkeys over levels found when the diet contained a minimum nutritional level of 0.2 or 0.3 mg/kg. On general, breast had a higher content of selenium than leg.

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