The effects of a higher amount of iodine supplement on the efficiency of laying hens fed extruded rapeseed and on eggshell quality

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ABSTRACT: The objective of this experiment was to study the effects of feeding 6.07 mg/kg of iodine in comparison with 3.57 mg/kg of iodine as a supplement in diets with different levels of extruded rapeseed (4.5, 9.0 and 13.5%) for a period of 52 weeks. The higher amount of iodine had the most marked effect on the egg mass production and on the feed : egg mass ratio when the hens were fed 9.0% extruded rapeseed in the diet. The egg mass production increased from 55.5 ± 1.06 g/d to 57.8 ± 1.12 g/d and the feed : egg mass ratio was improved from 2.15 kg/kg to 2.02 kg/kg. The eggshell weight ratio significantly ($P < 0.05$) increased in all groups with the higher level of iodine. The higher level of iodine significantly ($P < 0.05$) increased eggshell thickness in the groups with 9.0 and 13.5% of extruded rapeseed and it also significantly ($P < 0.01$) increased eggshell strength in the groups with 4.5 and 9.0% of rapeseed in the diets.

Keywords: egg mass; feed: egg mass ratio; eggshell weight ratio; eggshell thickness; eggshell strength, goitrogens

The nutrient profile of rapeseed makes it an ideal ingredient for high nutrient dense diets. The content of goitrogens (glucosinolates) in rapeseed has been markedly reduced by genetic selection. But rapeseed still has the sufficient goitrogen activity to cause a significant increase in the weight of the thyroid. However, according to Leeson and Summers (1997), this does not appear to be a problem affecting the performance of poultry. The products of glucosinolate degradation are accountable for the goitrogen activity. The negative effects of thiocyanates, which are also a by-product from the breakdown of glucosinolates, can be reduced by addition of extra iodine (McDowell, 1992) because they competitively inhibit the movement of iodine in the thyroid gland (Karlson *et al*., 1987). The process of extrusion has also been used to reduce the glucosinolate content in the diets, but the effect of this treatment is not valued unambiguously (Fenwick *et al*., 1986; Smithard and Eyre, 1986; Jeroch *et al*., 1998).

The objective of our study was to investigate the effects of two different amounts of iodine supplement while feeding three different amounts of extruded rapeseed on the efficiency of laying hens as well as on the quality of eggshells in the period from 21 to 72 weeks of age.

MATERIAL AND METHODS

Ninety-six Isabrown laying hens were housed in cages (2 birds per cage) in an air-conditioned facility. They were divided into six groups; two amounts of iodine (3.57 mg/kg and 6.07 mg/kg) and three levels of rapeseed (4.5%, 9.0% and 13.5%) were used

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Table 1. The composition of the diets

Composition (g/kg)	R1	R1I	R2	R2I	R3	R3I
Rapeseed – extruded	45	45	90	90	135	135
Wheat – extruded	60	60	120	120	180	180
Pea – extruded	45	45	90	90	135	135
Wheat	450	450	330	330	210	210
Soybean meal	120	120	90	90	60	60
Corn	140	140	140	140	140	140
Fish meal	30	30	30	30	30	30
Limestone	77	77	77	77	77	77
NaCl	1.76	1.76	1.76	1.76	1.76	1.76
Dicalcium phosphate	20.35	20.35	20.35	20.35	20.35	20.35
Premix*	10.89	10.89	10.89	10.89	10.89	10.89
$Ca(IO_3)_2$ (mg/kg)	–	3.85	–	3.85	–	3.85
Number of hens	16	16	16	16	16	16

*The premix supplemented to 1 kg of feed had the following amounts of nutrients:
Cu – 4.94 mg, Fe – 142.8 mg, Zn – 60.4 mg, Mn – 59.9 mg, Co – 0.24 mg, I – 3.57 mg, Se – 0.44 mg, retinol – 3.3 mg, cholecalciferol – 0.05 mg, tocopherol – 25.2 mg, menadione – 2.2 mg, thiamine– 2.24 mg, riboflavin – 7.85 mg, pyridoxine – 3.27 mg, cyanocobalamin – 0.018 mg, biotin – 0.11 mg, niacin – 25.1 mg, folic acid – 1.05 mg, calcium pantothenate – 9.8 mg, choline – 508.8 mg, L-lysine – 44 mg, DL-methionine – 773.6 mg, L-threonine – 39.6 mg

Table 2. The characteristics of the diets

Characteristics (g/kg)	Diets		
	R1 + R1I	R2 + R2I	R3 + R3I
Dry matter	917.6	922.2	928.1
AME_N (MJ/kg)	12.7	13.1	13.4
Crude protein (N × 6.25)	178.6	176.9	175.3
Methionine	3.73	3.72	3.71
Sulphuric amino acids	6.79	6.59	6.39
Threonine	6.34	6.44	6.53
Crude fibre	35.13	44.44	53.76
Ca	36.16	36.31	36.46
P	8.37	8.54	8.7
Na	1.67	1.60	1.53
Mg	1.53	1.53	1.52

in the diets. The amounts of extruded rapeseed and iodine in the diets were as follows: R1 – 4.5% of rapeseed and 3.57 mg/kg of iodine, R1I – 4.5% of rapeseed and 6.07 mg/kg of iodine, R2 – 9.0% of rapeseed and 3.57 mg/kg of iodine, R2I – 9.0% of rapeseed and 6.07 mg/kg of iodine, R3 – 13.5% of rapeseed and 3.57 mg/kg of iodine, R3I – 13.5% of rapeseed and 6.07 mg/kg of iodine. The iodine was

supplemented to the diets in the form of $Ca(IO_3)_2$. The rapeseed was extruded together with wheat and peas. The composition of the feed and the nutrient contents are shown in Tables 1 and 2. The hens were fed *ad libitum*. The eggs were collected and weighed each day during the experimental period when the hens were between 21 and 72 weeks of age. Feed consumption was measured at weekly intervals. The egg mass production and the feed : egg mass ratio were calculated from the data. The quality of eggshells was analysed every 28 days by determining the strength, thickness and eggshell weight ratio. The effect of iodine amount on the observed characteristics was evaluated by *t*-test (Snedecor and Cochran, 1967).

RESULTS AND DISCUSSION

The total glucosinolate content in the feed for groups R1 and R1I was 0.50 μmol/g. Diets R2 and R2I contained 0.99 μmol/g, and in diets R3 and R3I it was 1.49 μmol/g. The hen performance and the quality of eggshells are shown in Table 3. The higher level of iodine did not have any effect on the feed intake of laying hens. A marked effect of the higher level of dietary iodine was exerted on the egg production when feeding 9.0% rapeseed. The egg production in the group R2I was higher by 11.6 eggs compared to group R2. Also when feeding 4.5% rapeseed, the higher iodine supplement had a positive effect on the number of produced eggs (the difference was 5.7 eggs/hen). But in the group R3I the number of eggs was lower than in the group R3 (about 3.6 eggs/hen). When feeding 9.0% and 13.5% rapeseed the extra iodine enhanced the egg weight: in group R2I it was about 0.3 g and in group R3I it was about 1.7 g compared with groups R2 and R3. The egg mass production was also improved due to the higher level of iodine in the groups R2I and R3I. When feeding 4.5% rapeseed, the higher level of iodine had a negative effect on egg weight and egg mass production. Probably the content of glucosinolates was low enough and the level of iodine at 3.57 mg/kg was adequate to decrease the negative effect of goitrogens on the egg mass. The higher level of iodine (6.07 mg/kg) already had a negative effect on the hen performance as we found before (Lichovnikova *et al.*, 2003). The higher amount of iodine combined with all the different amounts of extruded rapeseed in the diets had the positive effect on the feed : egg mass ratio.

Table 3. The effect of iodine supplementation on performance of laying hens

	R1	R1I	R2	R2I	R3	R3I
Feed intake (g/d)	122.2 ± 0.73	113.1 ± 1.01	119.3 ± 0.92	116.6 ± 0.99	111.6 ± 1.15	113.0 ± 1.03
Egg production (eggs/hen)	324.4	330.1	318.3	329.9	323.3	319.7
Egg weight (g)	63.3 ± 0.55	61.8 ± 0.52	63.2 ± 0.54	63.5 ± 0.58	61.0 ± 0.47	62.7 ± 0.59
Egg mass (g/d)	56.6 ± 1.08	56.1 ± 0.82	55.5 ± 1.06	57.8 ± 1.12	54.3 ± 0.89	55.2 ± 1.05
Feed/egg mass ratio (kg/kg)	2.16	2.02	2.15	2.02	2.06	2.05
Eggshell weight ratio (%)	9.18 ± 0.063^{A}	9.45 ± 0.060^{B}	9.10 ± 0.067^{a}	9.29 ± 0.055^{b}	9.20 ± 0.065^{a}	9.39 ± 0.054^{b}
Eggshell thickness (mm)	0.380 ± 0.0024	0.383 ± 0.0021	0.374 ± 0.0024^{a}	0.382 ± 0.0023^{b}	0.374 ± 0.0020^{A}	0.383 ± 0.0021^{B}
Eggshell strength (N/cm^2)	29.1 ± 0.71^{A}	34.0 ± 0.54^{B}	33.1 ± 0.53	32.4 ± 0.57	32.3 ± 0.55^{A}	36.2 ± 0.53^{B}

$^{a, b}$means of the same order designated by different letters are significantly different ($P < 0.05$) concerning the effect of iodine at the same level of rapeseed
$^{A, B}$means of the same order designated by different letters are significantly different ($P < 0.01$) concerning the effect of iodine at the same level of rapeseed
$^{A, B}$means of the same order designated by different letters are significantly different ($P < 0.001$) concerning the effect of iodine at the same level of rapeseed

The highest positive effect of feeding increased amounts of dietary iodine was observed when feeding 9.0% rapeseed. In the groups R3 and R3I the amount of glucosinolates was the highest. The iodine supplementation probably could not totally repress the negative effect of goitrogens, which was confirmed by Underwood and Suttle (1999).

Iodine supplementation had a positive effect on the eggshell weight ratio when feeding all the different amounts of extruded rapeseed. The difference 0.27% between groups R1 and R1I was significant ($P < 0.01$). The differences between groups R2 vs. R2I and R3 vs. R3I in both cases 0.19% were also significant ($P < 0.05$). The thickness of eggshell was also higher in the groups with higher level of iodine (R1I, R2I, R3I) than in the groups with 3.57 mg/kg iodine (R1, R2, R3). The difference 0.008 mm between R2 and R2I was significant ($P < 0.05$), and the difference 0.009 mm between R3 and R3I was also significant ($P < 0.01$). In the groups with 4.5% and 13.5% of extruded rapeseed the higher level of iodine significantly ($P < 0.001$) improved the eggshell strength. Between R1 and R1I the difference was 4.9 N/cm^2 and between R3 and R3I the difference was 3.9 N/cm^2. No noticeable difference was observed between R2 and R2I.

The higher level of iodine had a positive effect on egg weight, egg mass production and feed : egg mass ratio in laying hens fed 9.0 and 13.5% of extruded rapeseed in the diets. The higher level of iodine in the diets containing extruded rapeseed had a significant effect and improved eggshell weight ratio, eggshell thickness, and eggshell strength (except the eggshell strength in the group which received 9.0% of rapeseed). The positive results of feeding higher levels of iodine (6.07 mg/kg) along with higher levels of extruded rapeseed in the diets for laying hens were proved.

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ABSTRAKT

Vliv vyššího doplňku jodu na užitkovost slepic a kvalitu skořápy při zkrmování extrudované řepky

Cílem pokusu bylo porovnat vliv zkrmování 6,07 mg a 3,57 mg jodu v kg směsi slepicím, které byly krmeny směsmi s různým obsahem extrudované řepky (4,5, 9,0 a 13,5 %) během 52 týdnů. Vyšší množství jodu mělo nejvýraznější vliv na produkci vaječné hmoty a konverzi krmiva při zkrmování 9 % extrudované řepky ve směsi. Produkce vaječné hmoty vzrostla z 55,5 ± 1,06 g/den na 57,8 ± 1,12 g/den a konverze krmiva se zlepšila z 2,15 kg/kg na 2,02 kg/kg.

Hmotnostní podíl skořápky se průkazně statisticky ($P < 0,05$) zvýšil ve všech skupinách s vyšším obsahem jodu. Vyšší hladina jodu statisticky průkazně ($P < 0,05$) zvýšila tloušťku skořápky při zkrmování 9,0 a 13,5 % extrudované řepky a také statisticky průkazně ($P < 0,01$) zvýšila pevnost skořápky u skupin krmených 4,5 a 9,0 % extrudované řepky ve směsích.

Klíčová slova: vaječná hmota; konverze krmiva; hmotnostní podíl skořápky; pevnost skořápky; tloušťka skořápky; goitrogeny

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