THE EFFECTS OF EXCESSIVE IODINE INTAKE ON THE ACTIVITY OF LEUKOCYTES AND THE LEVEL OF PLASMATIC PROTEINS IN LAYING HENS*

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The effects of a 74-day increased iodine intake in form of KI on the activity of leukocytes and the concentration of plasmatic proteins were studied in four groups of layers of the laying hybrid Brown Hisex – control group A and experimental groups B, C and D ($n = 11$ in each group). The iodine supplementation to complete mixture for layer N1 with the content of 0.3–0.7 mg $I.kg^{-1}$ amounted in the B group to 3.5 mg, C 1.3–10 mg and D 7–15 $mg.kg^{-1}$ (Table I). The iodine status in the organism of layers was evaluated in compliance with its content in blood plasma and in egg yolk colorimetrically after alkaline digestion applying the Sandell-Kolthoff method (Bednář et al., 1964). The additive iodine intake resulted in a transient increase of iodine in blood plasma peaking in 3rd week (on Day 21), (Table II, Fig. 1), the highest values were reached in groups with the initial intake exceeding 3.5 mg $I.kg^{-1}$ mixture: in group B from 62.4 before load to 4 874.8 $\mu g.l^{-1}$ and in group D from 63.5 to 6 502.1 $\mu g.l^{-1}$ ($P < 0.01$). The iodine accumulation in egg yolk (Table II) in comparison with its content in blood plasma was prolonged and the transovarial iodine transfer as a homeostatic mechanism lasted for about 10 weeks (74 days). The successive iodine decrease even in egg yolk was probably related to homoeorhetic mechanisms, e.g. decreased absorption. The statistically significant decrease of phagocytic heterophile activity (Table IV, Fig. 2) and the phagocytic index, which was observed during the period of iodine accumulation in blood plasma exceeding the concentration of 4 800 $\mu g.l^{-1}$, suggest a direct inhibitive effect of the increased iodine concentration in blood on the live manifestations of leukocytes. The relative increase of heterophiles ($P < 0.01$) at the expense of lymphocytes in B and D groups in the first half of the experiment (Table III) can be related to the histhologically determined infiltration of thyroid glands with lymphocytes comparable with spontaneous autoimmune thyreotidis. The growth of γ globulines (Table V) in groups with a higher iodine intake, e.g. in group D, from 6.39 $g.l^{-1}$ before experiment to

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13.17 g.l^{-1} in the second experimental phase, can be attributed to the current autoimmune response in relationship with excessive iodine intake.

iodine excess; leukocytes; phagocytic activity; plasmatic protein; iodine in plasma; iodine in eggs

INTRODUCTION

Thyroid gland disorders based etiologically on insufficient iodine intake or utilization seem to represent a current health issue in 118 countries of the world. One of the options of a regular and well-balanced iodine intake in human population is its increase in animal-based foods via iodine supplemented diets of farm animals (Anke et al., 1994; Herzig, Kursa, 1997; Rambeck et al., 1997). By enriching a feed mixture for layers by 10 mg iodine per kg, the concentration of iodine in egg yolk amounting to 20 000 µg in 1 kg fresh matter can be achieved, at the intake of one enriched egg, this concentration is equivalent to a three to four day human iodine requirement (Kroupová et al., 1997). The efforts aimed at increasing the iodine levels in animal-based products have to incorporate the control of biological effects of excessive iodine including its effects on the internal animal environment. The most relevant manifestations of iodopoenia in farm animals include decreased fodder intake resulting in lower yields (Herzig, Suchý, 1996), lower haemoglobin levels, lower iron concentrations in liver, decreased milk production, extreme iodine level growth in blood serum, milk, urine and faeces (Kirschmann, 1990). Haggard et al. (1980) recorded an inhibition of phagocytic activity and decreased leukocyte levels in calves at the daily iodine intake amounting to 1.25 mg, and Hillman and Curtis (1980) observed in cows with the daily intake of 164 mg iodine an increase in neutrophil granulocytes, plasmatic protein including globulines and a decrease of lymphocytes. Toxical iodine effects have been described by Christensen and Ort (1990) in turkeys already at the dose of 35 mg.kg^{-1} feed mix. Richter (1995) detected ovulation disorders and oviduct inflammation in layers loaded with 40 mg I.kg^{-1} and Jiang-Qingyan (1996) attributed decreased egg yields, decreased fertility and hatchability to iodine excess. Taking health risks related to excessive iodine intake into consideration, the European standard 96/7/EWG states the maximum iodine intake in feed at 10 mg.kg^{-1}. Under our conditions the standardised iodine requirement data in layers range between 0.35 and 0.50 mg.kg^{-1} feed mix (Zelenka et al., 1993).

MATERIAL AND METHODS

The effects of excessive iodine intake was studied at the beginning of the first laying cycle in four groups of layers of the laying hybrid Brown Hisex, each group consisting of 11 layers (control group A, experimental groups B, C and D). The layers were put in a shed on deep bedding, at the average day and night temperature 20 °C, with all-day illumination. During the experiment (74 days), the layers were fed *ad libitum* the feed mix N_1 containing 0.3–0.7 mg iodine.kg^{-1}. Experimental groups were fed with a diet enriched with a KI premix in compliance with Table I.

Blood for haematological tests was taken from *v. cutanea ulnaris*, then stabilised with heparin. The percentage representation of leukocytes was determined by the differentiation of 200 cells from blood smear after colouring with May-Grünwald and Giemsa-Romanowski solutions. The phagocytic activity of leukocytes was determined after one-hour incubation with microspheric hydrophilic particles (MSHP) in blood smear coloured in the same way as in the differentiation leukocyte calculation. Cells with three or more absorbed particles were evaluated as showing phagocytic effects. The phagocytic activity was determined in heterophylic granulocytes as the percentage of phagocytic heterophiles out of potential heterophiles. The phagocytic index was expressed in the mean count of phagocyting particles per one phagocytic heterophile. The leukocyte count was determined microscopically in Bürker's chamber, total protein by means of biuretic reaction and protein fractions of blood serum electrophoretically on cellulose-acetate sheets.

The iodine load in layers was evaluated in compliance with its content in blood plasma and egg yolk. Iodine was determined colorimetrically using a modified method based on Bednář et al. (1964).

I. Iodine supplement (mg.kg^{-1} of mixture N_1) and daily mixture intake (g) per layer

Days of iodine intake	Iodine addition in mg.kg^{-1} of mixture N_1				Daily mixture intake in g per layer							
	group				group							
	A	B	C	D	A		B		C		D	
					$\bar{x}$	s_x	$\bar{x}$	s_x	$\bar{x}$	s_x	$\bar{x}$	s_x
0	0	0	0	0	127.9	12.8	134.9	8.9	131.1	12.1	131.2	14.2
1–34	0	3.5	1.3	7.0	131.8	17.2	140.6	9.6	137.6	15.3	147.8	6.2
34–74	0	3.5	10.0	15.0	135.1	15.6	133.6	31.6	143.4	19.0	145.4	8.7

Note: Iodine content in the basic diet was increased from 0.3 to 0.7 mg I per 1 kg of mixture N_1 between 28th and 95th day of experiment

The results were processed using the statistic program STAT Plus (Matoušková et al., 1992).

RESULTS

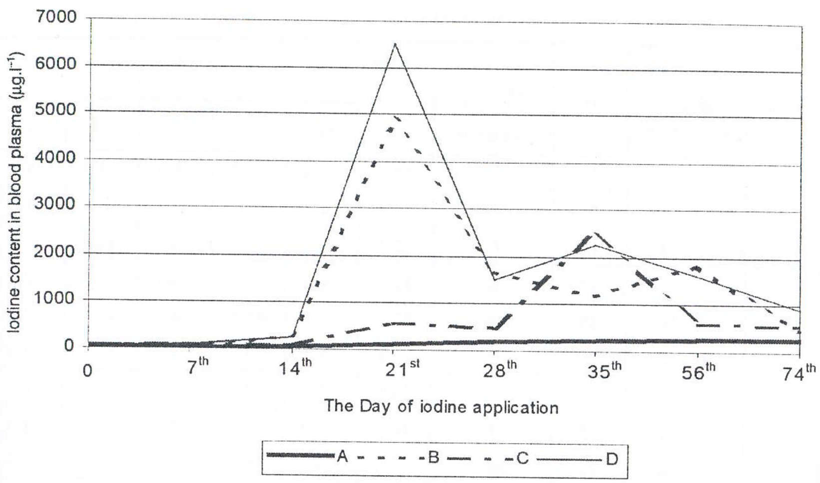
The intake of feed mix N_I enriched with 1.3–15 mg $I.kg^{-1}$ resulted in a significant increase of iodine concentration both in blood serum of layers and in egg yolk. The values in blood plasma (Table II, Fig. 1) grew already in the 3rd week, mostly in groups B and D with the additive intake of 3.5 and above mg $I.kg^{-1}$. In group B the iodine concentration in serum increased from 62.4 ± 17.9 before loading the hens with iodine to 4 874.8 ± 257.3 $\mu g.l^{-1}$ in the 3rd week of experiment and in the D group from 63.5 ± 27.2 to 6 502.1 ± 214.8 $\mu g.l^{-1}$ ($P < 0.01$). In groups C and D the successive decreasing trend, which was observed from week 4 of experiment, was temporarily interrupted by a further supplementation of iodine into feed mix (in group C from 1.3 to 10, in group D from 7 to 15 $mg.kg^{-1}$). In experimental groups the iodine accumulation in egg yolk grew approximately until week 10 (days 74), whereas a significant growth of iodine content in egg yolk was observed in weeks 3 to 4 (days 21st–28th) of its additive intake (Table II).

In the course of the 74-day experiment, the effects of supplementary iodine intake on leukocyte counts and the percentage representation of the individual types of leukocytes were studied seven times in total. The results are concentrated into separate periods of time in compliance with the levels of the iodine supplementation to feed mix (Table III).

The leukocyte counts in the control and experimental groups and their dynamics cannot be unambiguously attributed to their dependence on in-

II. The effect of excessive iodine intake on the iodine content in blood plasma and egg yolk

The Day of iodine application	n	Iodine content in egg yolk ($\mu g.kg^{-1}$)							
		A		B		C		D	
		$\bar{x}$	s_x	$\bar{x}$	s_x	$\bar{x}$	s_x	$\bar{x}$	s_x
0.	5	870.6	217.2	1 081.0	334.0	908.0	169.0	1 020.3	366.4
7th	5	1 119.4	340.1	4 666.0	200.1	4 500.0	281.0	5 808.5	1 235.6
14th	5	1 278.3	166.7	3 925.0	132.7	3 734.0	68.6	4 816.7	1 030.0
21st	5	1 840.2	478.6	5 938.6	628.6	4 559.7	78.6	13 401.0	2 700.7
28th	5	2 540.0	393.2	24 020.3	2 751.4	11 079.0	599.6	24 010.8	5 970.6
35th	5	3 600.6	172.5	23 300.2	1 280.8	14 230.2	1 761.0	20 110.0	1 336.2
56th	5	4 230.8	190.5	17 370.6	525.0	33 008.5	184.8	37 227.3	556.0
74th	5	4 605.5	1 240.0	13 898.0	1 562.2	18 835.0	1 906.0	42 371.2	2 943.0
81st	5	3 920.7	353.9	11 578.6	636.1	15 088.0	3 440.0	24 124.0	2 797.0
88th	5	3 522.3	328.0	11 284.3	2 982.8	11 200.0	190.2	18 920.4	601.0



1. Iodine content in blood plasma ($\mu g.l^{-1}$)

Continuation of Table II

n	Iodine content in blood plasma ($\mu g.l^{-1}$)							
	A		B		C		D	
	$\bar{x}$	s_x	$\bar{x}$	s_x	$\bar{x}$	s_x	$\bar{x}$	s_x
10	61.8	19.1	62.41	17.9	56.7	10.8	63.51	27.2
10	48.3	14.9	69.8	10.5	83.3	3.8	108.5	6.4
10	52.2	20.9	272.8	10.8	114.3	37.3	263.8	12.6
10	122.0	26.1	4 874.8	257.3	547.8	22.9	6 502.11	214.8
5	189.8	34.5	1 675.0	692.1	490.2	247.7	1 504.4	424.6
10	234.8	63.4	1 164.0	89.6	2 503.6	457.6	2 256.6	281.4
10	251.5	40.1	601.0	60.0	1 823.2	308.1	1 608.7	258.5
5	271.3	17.6	441.6	87.8	551.8	109.0	904.6	348.9

III. Dynamics of leukocytes, heterophiles and lymphocytes

Group	Days of iodine application	n	Iodine addition mg.kg^{-1} mixture N_1	Leukocytes g.l^{-1}		Heterophiles %		Lymphocytes %	
				$\bar{x}$	s_x	$\bar{x}$	s_x	$\bar{x}$	s_x
A	0	10	0	30.7	3.4	37.2	5.5	55.4	3.4
	1–34	25	0	36.4	4.8	41.1	7.2	56.6	7.0
	35–74	10	0	32.1	2.5	39.5	3.5	54.5	4.0
B	0	10	0	21.8	4.9	37.4[1]	4.7	57.0[2]	7.1
	1–34	25	3.5	32.1	4.7	44.5[1]	4.8	49.1[2]	3.9
	35–74	10	3.5	32.1	5.1	39.6	4.2	52.6	3.8
C	0	10	0	24.6	4.2	37.4	2.0	56.8	1.3
	1–34	25	1.3	36.0	4.0	39.6	2.7	53.5	2.3
	35–74	15	10	35.8	5.0	38.6	2.8	54.1	3.7
D	0	10	0	26.5	5.2	35.6[3]	2.8	59.0[4]	3.1
	1–34	25	7	35.5	4.1	43.0[3]	4.1	51.1[4]	4.4
	35–74	15	15	28.5	3.0	38.1	2.7	53.9	3.2

t-test: [1,2,3,4] ($P < 0.01$)

IV. The effects of excessive iodine intake on the phagocyte activity of heterophiles

The Day of iodine application	n	Phacocyte activity of heterophiles (%)							
		A		B		C		D	
		$\bar{x}$	s_x	$\bar{x}$	s_x	$\bar{x}$	s_x	$\bar{x}$	s_x
0.	10	35.7	2.6	37.0[1,2,3]	7.0	38.8	7.3	37.6[1,2,3]	7.3
7th	10	36.5	4.1	28.9	2.3	36.0	5.4	32.3	2.2
14th	10	39.7	5.8	26.7[1]	5.1	35.2	5.7	27.4[1]	5.3
21st	10	36.4	5.1	23.7[2]	1.7	34.2	3.4	24.2[2]	1.6
28th	5	36.7	3.7	26.0[3]	2.2	35.0	2.5	27.6[3]	2.3
35th	10	37.8	7.9	36.2	3.5	36.0	3.9	36.9	3.6
56th	10	40.2	2.1	38.7	1.3	39.0	3.5	38.4	1.7
74th	5	41.0	3.5	38.6	6.3	39.8	1.8	38.2	1.8

* The mean count of phagocyting particles per one phagocytic heterophile

t-test: [1,2,3] ($P < 0.01$), [4] ($P < 0.05$)

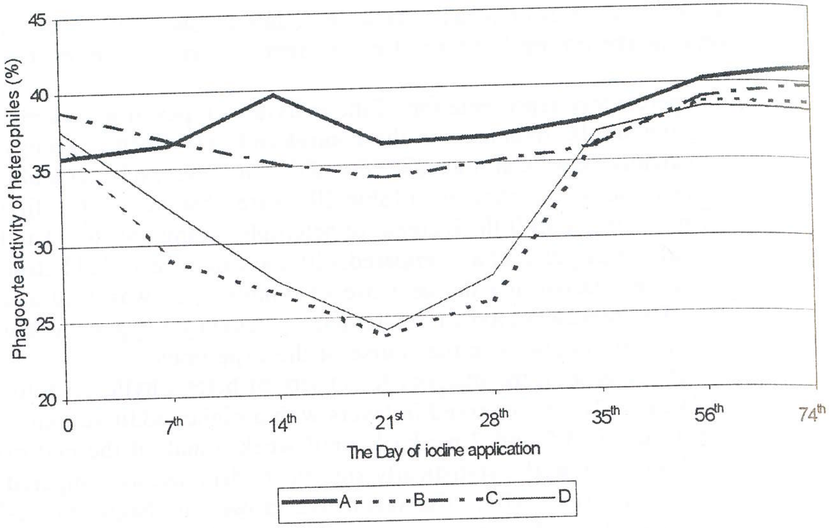
creased iodine intake. Lower mean leukocyte counts in the group with the highest iodine intake (group D 15 mg I.kg^{-1}) suggest a certain comparative trend.

Within the percentage representation of the individual types of leukocytes, not regarding the similar dynamics in the control and experimental groups, a certain statistically significant increase ($P < 0.01$) of heterophilic granulocytes and a decrease of lymphocytes (Table III) were observed in the first half of experiment. In group B the increase of heterophiles amounts to 19 and in group D nearly to 21 per cent as compared with the values recorded before the experiment was started and the decrease of lymphocytes was 13.9 and 13.3 per cent. The representation of the remaining leukocyte types did not show any significant variations in the course of the experiment.

A significant decrease in the phagocytic activity of heterophylic granulocytes (Table IV, Fig. 2) was observed in layers with a higher additive iodine intake (group B and D 3.5 and 7 mg.kg^{-1}) until week 3 and, at the end of week 3 (21st day), it showed a statistically significant decrease as compared with the initial values ($P < 0.01$). The successive growth in phagocytic activity was not affected by a further increase in iodine supplementation in feed mix, which occurred on day 35 of experiment in the groups D (from 7 to 15 mg) and C (from 1.3 to 10 mg.kg^{-1}). Simultaneously with the decrease of phagocytic activity, a fall in the levels of phagocytic index was recorded, which at the end of week 3 (21st day) of additive iodine intake, amounted in group B to 13.6 ± 0.8 and in group to D 14.4. ± 2.9, and in comparison with

Continuation of Table IV

n	Phagocytic index*							
	A		B		C		D	
	$\bar{x}$	s_x	$\bar{x}$	s_x	$\bar{x}$	s_x	$\bar{x}$	s_x
10	17.7	2.3	19.6[1,2,4]	2.4	17.4[4]	1.8	20.4[1,2,4]	3.4
10	17.1	0.7	15.6	1.1	16.6	0.8	15.6	4.1
10	17.3	2.4	14.8[1]	1.4	15.7	1.6	15.4[1]	2.4
10	17.6	0.6	13.6[2]	0.8	15.7[4]	0.6	14.4[2]	2.9
5	18.5	1.5	15.3[4]	2.7	15.9	1.8	14.8[4]	3.7
10	19.5	2.6	18.0	0.9	19.3	1.3	20.7	1.9
10	20.4	1.3	21.1	2.0	20.6	0.4	21.4	2.1
5	21.6	1.3	21.1	1.5	19.8	0.7	21.0	1.5



2. Phagocyte activity of heterophiles (%)

the control group A (17.6 ± 0.6) they reached statistically significantly lower values ($P < 0.01$).

The effects of increased iodine intake on the dynamics of plasmatic proteins and of the individual protein fractions are shown in Table V. In the course of the experiment, no statistically significant differences in total counts of plasmatic proteins between the control group and the experimental groups were detected. In the control group, a statistically significant drop ($P < 0.01$) in albumines, a growth in γ globulines ($P < 0.01$) and a decrease in α_1 or α_2 globulines ($P < 0.05$, 0.01) were found.

DISCUSSION

As stipulated in literature data (Kirschmann, 1990; Kaufmann, 1997; Bobek, 1998), the load of laying hens by graduated iodine doses was reflected in its increased levels in blood serum and egg yolk (Kroupová et al., 1999). A comparison of the dynamics of the iodine content in blood plasma and egg yolk (Table II, and Fig. 1) shows that the iodine culmination in egg yolk is prolonged and that the transovarial iodine transfer as a significant homoeostatic mechanism is effective for a period of about 10 weeks. Only then the homeorhetic mechanisms show their

V. Total proteins and protein fractions in the blood plasma iodine application

Group	Iodine addition mg.kg^{-1} mixture N_1	Parameter g.l^{-1}	Days of iodine application					
			0		1–34		35–74	
			$\bar{x}$	s_x	$\bar{x}$	s_x	$\bar{x}$	s_x
A	0	total proteins	48.90	2.26	44.20	3.80	42.50	2.90
		albumin	24.30^{1}	3.56	16.92	4.86	15.43^{1}	3.02
		α_1 globulin	4.54	1.95	3.44	1.50	2.89	0.51
		α_2 globulin	3.86	1.56	3.13	1.19	3.69	1.11
		β globulin	10.02	3.96	11.88	4.19	11.34	2.16
		γ globulin	6.16	3.32	8.26	2.82	9.18	1.70
B	3.5	total proteins	43.90	4.80	44.30	2.10	43.60	3.70
		albumin	20.89	2.10	21.26	1.63	20.49	4.27
		α_1 globulin	4.21^{2,8}	0.57	2.61^{8}	1.06	1.40^{2}	0.91
		α_2 globulin	3.25	1.27	2.65	0.84	2.44	0.52
		β globulin	9.66	1.18	9.52	2.12	9.15	4.57
		γ globulin	5.88^{3}	0.92	8.19	2.83	10.16^{3}	2.48
C	1.3–10.0	total proteins	43.9	3.00	42.50	2.30	41.20	2.60
		albumin	22.44	6.23	20.99	4.54	18.25	2.18
		α_1 globulin	3.95^{9}	1.44	2.72	1.31	1.94^{9}	0.32
		α_2 globulin	3.73	0.70	2.93	1.78	3.58	0.61
		β globulin	8.95	4.43	8.11	2.50	8.52	0.20
		γ globulin	5.27^{4}	2.45	7.22	2.29	8.94^{4}	2.55
D	7.0–15.0	total proteins	46.3	1.60	43.40	3.00	44.20	3.70
		albumin	20.32	3.79	17.22	3.47	21.03	3.09
		α_1 globulin	4.86^{5}	1.06	3.34	0.91	1.68^{5}	0.57
		α_2 globulin	4.58^{10}	2.54	3.16	1.12	1.33^{10}	0.44
		β globulin	10.97	0.78	8.11	3.34	6.63	5.61
		γ globulin	6.39^{6,7}	2.36	11.54^{6}	2.47	13.17^{7}	4.33

t-test: ^{1,2,3,4,5,6,7} ($P < 0.01$), ^{8,9,10} ($P < 0.05$)

effects (Kirchgessner, 1993), probably in relationship with the inhibited resorption (Kroupová et al., 1999), which results in decreased iodine levels even in egg yolk.

The decrease of phagocytic activity related to iodine load described by Hillman and Curtis (1980) in dairy cows and by Haggard et al. (1980) in calves focused in our experiment on the accumulation of iodine in blood and was only of transient character (Table IV, Fig. 2). The lowest values of phagocytic activity and similarly of phagocytic index were documented at the iodine concentrations in blood exceeding 4 800 $\mu g.l^{-1}$, i.e. in week 3 (on 21st day) of additive iodine intake in the experimental groups B and D. This finding suggests a direct inhibitive effect of an increased level of iodine in blood on the live manifestations of leukocytes. On the other hand, the relative increase of heterophiles at the expense of lymphocytes (Table III) in laying hens with the initial iodine intake exceeding 3.5 $mg.kg^{-1}$ feed mix can be considered a result of the infiltration of the thyroid gland by lymphocytes, as was observed by Kratochvíl et al. (1998) in laying hens loaded with excessive iodine.

The statistically significant increase of a globulines in layers with luxurious iodine intake (Table IV) is one of the characteristic changes in the representation of the individual fractions of plasmatic proteins. E.g. in group D (7–15 mg $I.kg^{-1}$ feed mix) the relative representation of γ globulines increased already in days 1–34 of the experiment from 13.8 per cent (6.39 $g.l^{-1}$) to 26.6 per cent, and in days 35–74 to 29.8 per cent (13.17 $g.l^{-1}$). The growth of γ globulines was in this group accompanied by a decrease of the levels of the remaining globuline fractions, in group B by a decrease recorded exclusively in α_1 and α_2 globulines. Regarding the fact that, in layers of the experimenting groups with a high iodine intake, lymphocytic infiltrations were observed in the histological examinations of the thyroid gland (Trávníček et al., 1999), which corresponded with the levels of spontaneous autoimmune thyreoitidis (Wick et al., 1989), the growth of γ globulines can be considered a phenomenon resulting from autoimmune reactions related to excessive iodine content.

References

ANKE, M. – GLEI, M. – ANGELOW, L. – GROPPEL, B. – ILLING H.: Kupfer, Jod und Nickel in Futter- und Lebensmitteln. Übers. Tierernährg., *22*, 1994: 321–362.

BEDNÁŘ, J. – RÖHLING, S. – VOHNOUT, S.: Příspěvek ke stanovení proteinového jodu v krevním séru (Contribution to determination of protein iodine in blood serum). Českoslov. Farm., *13*, 1964: 203–209.

BOBEK, S.: Profylaktyka jodowa u zwierzat. Med. Wet., *54*, 1998: 80–86.

CHRISTENSEN, V. L. – ORT, J. F.: Iodine toxicity in White Turkey breeder hens. Poult. Sci., *70*, 1990: 2402–2410.

HAGGARD, D. L. – STOWE, H. D. – CONNER, G. H. – JOHNSON D. W.: Immunologic effects of experimental iodine toxicosis in young cattle. Am. J. Vet. Res., *41*, 1980: 539–543.

HERZIG, I. – KURSA, J.: Současný stav zásobení hospodářských zvířat jodem (Present view of supply of livestock with iodine). Krmivářství, *4*, 1997: 31–32.

HERZIG, I. – SUCHÝ, P.: Současný pohled na význam jodu pro zvířata (Present view of importance of iodine for animals). Vet. Med. – Czech, *41*, 1996: 379–386.

HILLMAN, D. – CURTIS, A. R.: Chronic iodine toxicity in dairy cattle: blood chemistry, leukocytes, and milk iodine. J. Dairy. Sci., *63*, 1980: 55–63.

JIANG-QINGYAN: Effects of high dietary iodine on the reproductive performance of hens. J. South China Agric. Univ. (China), *17*, 1996: 33–38.

KAUFMANN, S.: Ergänzende Strategieren zur Bekämpfung von Jodmangel in Deutschland und Südostasien. [Dissertation.] TU München, Fakultät für Landwirschaft und Gartenbau 1997. 95 pp.

KIRSCHMANN, S.: Nutrition Almanac. New York, Donnelley and Sons Company 1990. 340 pp.

KIRCHGESSNER, M.: Homeostasis and homeorhesis in trace element metabolism. In: ANKE M. et al.: Trace Elements in Man and Animals. TEMA-8, Verl. Media Touristik 1993: 4–21.

KRATOCHVÍL, P. – TRÁVNÍČEK, J. – KROUPOVÁ, V. – KRABAČOVÁ I.: Vliv příjmu jodu na stav štítné žlázy slepic (The effect of iodine intake on thyroid gland of hens). In: Sbor. Aktuální problémy chovu, zdraví a produkce drůbeže (Proc. Tropical problems of rearing, health and production of poultry). České Budějovice, Zemědělská fakulta JU, 1998: 151–152.

KROUPOVÁ, V. – KURSA, J. – KRATOCHVÍL, P. – TRÁVNÍČEK, J.: Produkce vajec obohacených o jód (Production of eggs enriched with iodine). Agroregion 97, II, České Budějovice, Zemědělská fakulta JU, 1997: 281–282.

KROUPOVÁ, V. – TRÁVNÍČEK, J. – KURSA, J. – KRATOCHVÍL, P. – KRABAČOVÁ, I.: Obsah jodu ve vaječném žloutku při jeho nadměrném příjmu nosnicemi (The content of iodine in egg yolk at excessive intake by laying hens). Czech J. Anim. Sci., *44*, 1999: 369–376.

MATOUŠKOVÁ, O. – CHALUPA, J. – CÍGLER, M. – HRUŠKA, K.: Statistický a grafický systém STAT Plus, verze 1.01. Uživatelská příručka (Statistical and graphic system STAT Plus, version 1.01. User's manual). Brno, Výzkumný ústav veterinárního lékařství 1992: 168 pp.

RAMBECK, W. A. – KAUFMANN, S. – FENG, J. – HOLLWICH, W. – ARNOLD R.: Verbesserung der Jodversorgung des Menschen durch Jodierung von Schweinenfutter. Tierärztl. Praxis, *25*, 1997: 312–315.

RICHTER, G.: Einfluss der Jodversorgung der Legenhennen auf den Jodgehalt im Ei. In: Mengen- und Spurenelemente. 15. Arbeitstagung. Leipzig, Verlag Harald Schubert 1995: 457–464.

TRÁVNÍČEK, J. – KROUPOVÁ, V. – KRATOCHVÍL, P. – KRABAČOVÁ I.: Vliv nadbytečného příjmu jodu a strumigenních faktorů na histometrické parametry štítné žlázy nosnic (The effect of excessive intake of iodine and thyroiditis factor on histometric parameters of thyroid gland of hens). Vet. Med. – Czech, *44*, 1999: 177–182.

WICK, G. – BREZINSCHEK, H. P. – HÁLA, K. – DIETRICH, H. – WOLF, H. – KRÖMER, G.: The Obese Strain (OS) of chickens: an animal model with spontaneous autoimmune thyroiditis. Adv. Immunol., *47*, 1989: 433–500.

ZELENKA, J. – ZEMAN, L. – KOČÍ, S. – KOČÍOVÁ, Z. (1993): Potřeba živin a tabulky výživné hodnoty krmiv pro drůbež. Komise výživy hospodářských zvířat ČAZV (Demand of nutrients and table of nutritive value of feed-stuffs for poultry. Commission for livestock nutrition). 1st ed. 1993. 54 pp.

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Vliv nadbytečného příjmu jódu na aktivitu leukocytů a hladinu plazmatických bílkovin u nosnic.

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U čtyř skupin nosnic nosného hybrida hisex hnědý – kontrolní skupiny A a pokusných skupin B, C a D (v každé skupině $n = 11$) – byl sledován vliv 74denního příjmu zvýšených dávek jódu ve formě KI na aktivitu leukocytů a koncentraci plazmatických bílkovin. Přídavek jódu ke kompletní krmné směsi pro nosnice N_1 s obsahem 0,3–0,7 mg I.kg^{-1} byl u skupiny B 3,5 mg, C 1,3–10 mg a D 7–15 mg.kg^{-1} (tab. I). Stav jódu v organismu nosnic byl posuzován podle jeho obsahu v krevní plazmě a ve vaječném žloutku kolorimetricky po alkalickém spalování podle Sandell-Kolthoffa (B e d n á ř et al., 1964). Aditivní příjem jódu vedl k přechodnému vzestupu jódu v krevní plazmě s vrcholem ve 3. týdnu (21. dnu) – tab. II, obr. 1, nejvíce u skupin s počátečním příjmem nad 3,5 mg I.kg^{-1}: u skupiny B z 62,4 před zátěží jódem na 4 874,8 µg.l^{-1} a u skupiny D z 63,5 na 6 502,1 µg.l^{-1} ($P < 0,01$). Kumulace jódu ve vaječném žloutku (tab. II) se ve srovnání s jeho obsahem v krevní plazmě prodloužila a jako homeostatický mechanismus se transovariální přenos jódu uplatňoval po dobu přibližně 10 týdnů. Následující pokles jódu i ve žloutku byl pravděpodobným důsledkem homeorhetických mechanismů, například sníženého vstřebávání. Statisticky významný pokles fagocytární aktivity heterofilů (tab. IV, obr. 2) a fagocytárního indexu, ke kterému došlo v období kumulace jódu v krevní plazmě převyšující koncentraci 4 800 µg.l^{-1}, naznačují přímý inhibiční efekt zvýšené koncentrace jódu v krvi na životní projevy bílých krvinek. Relativní vzestup heterofilů ($P < 0,01$) na úkor lymfocytů u skupin B a D v první polovině pokusu (tab. III) je možné dát do souvislosti s histologicky zjištěnými infiltracemi štítných žláz lymfocyty odpovídající stavům spontánní autoimunní tyreoitidy. Nárůst globulinů (tab. V) u skupin s vyšším příjmem jódu, například u skupiny D z 6,39 g.l^{-1} před pokusem na 13,17 g.l^{-1} ve druhé fázi pokusu, mohou být projevem probíhajících autoimunních reakcí v souvislosti s nadbytečným příjmem jódu.

nadbytek jódu; leukocyty; fagocytární aktivita; plazmatické bílkoviny; jód v plazmě; jód ve vejcích

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