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CONSEQUENCES OF IODINE DEFICIENCY IN CATTLE IN SOME REGIONS OF THE CZECH REPUBLIC*

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The contribution presents the data on prevalence of clinical symptoms of iodine withdrawal in calves according to the occurrence of goitre. Diagnostics was based on clinical picture, postmortal and laboratory findings. Among 1 355 calves examined during nine years on farms in eight districts of south-western part of the Czech Republic the disorder of the thyroid gland has been detected in 404 individuals, 1–21 days old. Frequency of findings varied in different herd. Extreme weight of strumose thyroid gland (720 g) corresponds to 70-fold of normal thyroid glands in calves of the same age. Enlarged thyroid gland induced complications during parturition, after birth caused dyspnoe by pressure on the larynx and trachea, leading to exitus in first hours of life, made difficult intake of liquids and feeds. Circulatory apparatus showed arrhythmia, instability of heart rate, congestion in the region of *arteriae carotis* and *venae cavae inferior*. In ten cases local partial baldness on buttock, thighs and near muzzle. Generalized congenital loss of hair found in two individuals together with bulging of frontal part of neocranium. Iodine concentration in milk of dairy cows with occurrence of goitre ranged from 10 to 30.8 $\mu\text{g}\cdot\text{l}^{-1}$ and testifies the deficient iodine intake in cows during pregnancy. These levels are significantly lower compared with iodine content in milk of cows without finding of goitre in their progeny (on average 40 $\mu\text{g}\cdot\text{l}^{-1}$). Origin of iodopenia with subsequent morbidity is presented in connection with the administration of concentrates and cereal meals of exclusively local provenance without enrichment by iodine. Iodine withdrawal was deepened by higher contents of nitrates in feeds and potable water and presence of plants of the cabbage family in feed rations. Successful therapy and metaphylaxis by preparations containing iodine (potassium iodatum, Lugol's solution, Intrajodin) confirmed these conclusions.

dairy cow; milk; calves; thyroid gland; pathology; goitre; diagnostics; therapy

* This study has been supported by the Grant Agency of the Czech Republic (Grant No. 524/97/654).

INTRODUCTION

The greater part of the Czech Republic is a traditional place with deficiency of iodine and with subsequent endemic occurrence of diseases from iodine deficiency. This situation is related to some regions of the Českomoravská Highlands, Šumava Mountains and Jizerské Mountains (Podoba, Langer, 1993). Following the whole-area survey of the population of 40 to 50 old humans, Šilink and his colleagues proposed and materialized in the CR enrichment of edible salt for consumers by potassium iodide which led to fundamental improvement. Recently, clinical endocrinologists have been finding that occurrence of manifestations of iodine deficiency is increasing again (Hníková, 1995). In this association, there are important data that during their origin and development along with primary iodopenia, based on some peculiarities of iodine circulation, factors deteriorating iodine utilization in the body are applied (Stárka, 1995). This antithyroid effect is typical for some pharmaceuticals (derivatives of thiouracil, of natural substances these are aglycons of thioglycosinolates and cyanogenic glycosides, flavonids and humic substances. Of contaminating substances, strumigenic effects have been recorded particularly for polychlorinated biphenyls, polycyclic aromatic hydrocarbons (benzpyrene etc.), insecticides (DDT), pesticides (paration etc.) and not last also PVC (Langer, 1993).

Current knowledge show that consequences of iodine deficiency are much wider that it has been predicted earlier. Though most frequent thyreopathy of this origin is goitre, iodine deficiency has negative impact on infant and neonatal mortality, fertility and physical and psychic qualities of afflicted population (Zamrazil, 1995).

The interest of agricultural scientific branches in these problems is induced by identical consequences in which result from insufficient saturation of iodine in livestock. Veterinary and other institutions point out as original subclinical symptoms (disorders of fertility, reduced growth, production, resistance), as the reduction of iodine content in milk and urine of dairy cows (Groppe et al. 1986a, b; Herzig et al., 1996a, b) as well as the occurrence of goitre in new-born kids (Körber et al., 1985; Gürtler et al., 1989; Anke, 1995).

News on occurrence of goitre in domestic ruminants in the Czech Republic are recent (Čada, 1988; Huml, 1992; Kurša et al., 1992, 1994). Related information from Slovakia have been reported by Bireš et al. (1993, 1996a, b). Topical problem in some regions in recent time has become goitre of calves (Čada, 1988; Kroupová et al., 1991). The presented study gives data on prevalence of disorder in calves during the years 1988 to 1997 in

some regions of southern and western Bohemia and knowledge of diagnostic aspects of disease.

MATERIAL AND METHOD

The study is concentrated on analysis of health situation in selected localities. Consulting examinations were accomplished on impulse given by veterinary service and spontaneous concern of breeders to help to solve this problem.

Prevalence analysis is a result of studies done particularly in southern and western Bohemia. They were directed to pathophysiological and pathomorphological consequences and manifestations of iodopenia and to definition of syndrome of iodine deficiency in cattle.

Extraordinary attention has been paid to palpation of the thyroid gland of calves, in which positive finding is first signal of goitre occurrence. Classification criteria for palpation findings are characterized in Tab. I. Simultaneously with it, dissections of dead, or slaughtered animals were done.

I. Classification of palpation changes in thyroid gland of calves

Group	Degree of enlargement	Palpation finding
1.	0	thyroid gland almost non-palpable
2.	+ -	thyroid gland is palpable, both lobes are distinguished
3.	+	gland is palpable, slightly enlarged, of size 3 x 2.5 x 1 cm
4.	++	gland is palpable, enlarged, of size approx. 5 x 4 x 1.5 cm
5.	+++	enlargement is visible, signs of congestion and compression (venostasis)

In breedings with goitre occurrence in new-born calves, iodine content in milk of dairy cows was monitored. Alkaline dry combustion and subsequent colorimetric determination after Sandel-Kolthoff were used (Bednář et al., 1964).

To treat goitre solutions of potassium iodide were administered per os or parenterally, or in combination with iodine (Lugol's solution) and the preparation Intrajodin (injection solution contains 2% ionogenic iodine) in a rate 0.5-1.0 ml per toto.

Metaphylactic interventions were directed to cope with iodopenia in high-pregnant cows and heifers. Replicated medication by Intrajodin was applied

in different modifications (e.g. intramuscular application of 1–1.5 ml) or water solution of potassium iodide containing 30 g KI in 1 000 ml of water twice a week 20 ml per 20 animals by free sprinkling of concentrate given to trough.

RESULTS

During eight-year studies in 25 herd of dairy cows 1 355 calves were clinically tested from birth to 3 weeks of age (Tab. II). In this set in 404 animals (29.8%) much greater goitre was observed – by characteristics of palpation changes in thyroid gland in groups 3, 4 and 5 (Tab. I). In 63 calves (4.6%) the finding was determined as uncertain. Thyroid gland of 888 calves (65.6%) was almost impalpable, i.e. negative finding (group I).

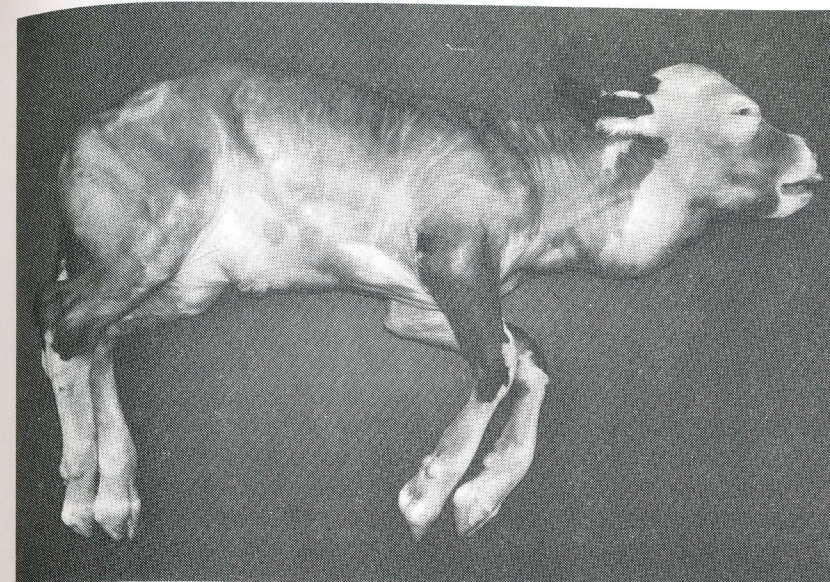
Dominant sign – enlargement of thyroid gland – occurred only in new-born calves. Thyroid gland of dams and afflicted calves of other dairy cows in the stable was without clinically apparent pathological deviations. Calves were born in worse condition, of little vitality, sometimes dead, some other time they died after several hours. Abortions of dead foetuses were frequent.

II. Localities of occurrence of the goitre in calves

District	Number of localities	Number of ill individuals
Benešov	2	45
České Budějovice	4	45
Český Krumlov	5	179
Klatovy	1	53
Plzeň	1	33
Prachatice	2	2
Strakonice	3	30
Tábor	1	7
Tachov	1	10

III. Clinical findings on the thyroid gland in calves

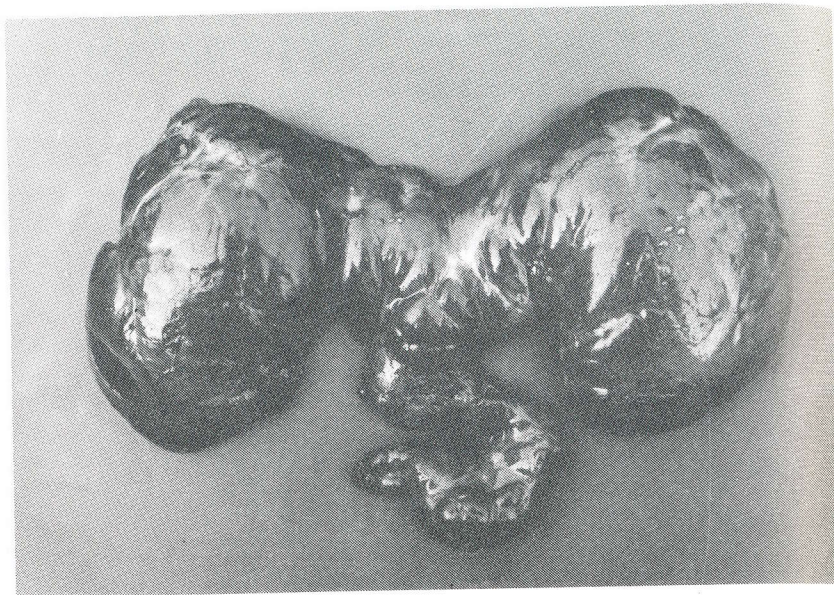
Examined	Finding					
	negative		dubious		positive	
number	number	%	number	%	number	%
1 355	888	65.6	63	4.6	404	29.8



1. Dead calf with goitre. Alopecia, skin and subcutis oedema

Enlargement of thyroid gland was variable, it fluctuated from slight deviations to multiple enlargement (Fig. 1), some other time global formation in *regio thyroidea* reached a size of 15 x 20 cm and weight of 720 g. It was always bilateral (Fig. 2), painless on palpation.

Extreme enlargement of thyroid gland complicated the course of the parturitions. Due to mechanical pressure on larynx and trachea (Fig. 3) manifestations of heavy dyspnoe have been reported after birth, particularly concomitant passage and intake of drinks and ending in severe cases by collapse and exitus. Dysphagia of the same origin was manifested by slow swallowing and fatigue during sucking and drinking. Arrhythmia and instability of heart rate were a regular finding, in advanced forms congestion in *v. jugularis* (Fig. 1). Near enlarged thyroid gland diffuse cold painless oedema of skin and subcutis were observed. In 10% of cases partial baldness on buttock, thighs, near muzzle. The hair without shine, dull, horrent. Generalized *alopecia congenita* was recorded in one of breedings in two patients with otherwise smooth skin without efflorescences, but with conspicuously reddish coloration, visible particularly in pigmentless regions of various parts of the body. Striking projecting of the frontal part of neocranium was observed in these animals.



2. Strumose thyroid gland. Goitre affects both lobes, enlarged isthmus and *Lobus pyramidalis*

To study iodopenia iodine content has been determined in 167 milk samples (Tab. IV). Iodine concentration in milk of the set of cows from stables with occurrence of goitre in new-born calves fluctuated from $10 \mu\text{g.l}^{-1}$ to $30 \mu\text{g.l}^{-1}$. Different levels of iodine in milk of dairy cows in stables with occurrence of goitre did not exceed the value $35.0 \mu\text{g.l}^{-1}$; 40.7% of average values varied on and below the limit $20 \mu\text{g.l}^{-1}$. Frequency of findings of average values of iodine concentrations in milk in these sets differed significantly from the values from breedings without pathological finding in thyroid gland in calves (Tab. V).

Pathological and anatomical changes are characterized by typical sectional finding, in two dead calves with developed goitre. They came from dam-first-calvers. These were full-term live-born female calves which died on days 1 and three after birth, 22 to 25 kg of weight. In first examination generalized alopecia with some indications of hairiness on auricles, near muzzle and eyes (Fig. 1). Another conspicuous change was a typical bulging reaching from *regio intermandibularis* caudally to the half of *regio coliventralis*. Bulging of frontal part of the cranium was also apparent. During the whole jugular fissures tubular-like formations predominated in subcutis



3. Trachea with compressive stenosis after pressure of enlarged thyroid gland

(also evident in figure). In preparation of the skin its focal effusion. Gelatinous oedematous infiltrates appeared also in subcutis, namely near enlarged thyroid gland, in *intermandibularis* and in orbit. Thyroid glands in both calves were symmetrically enlarged in both parts (Fig. 2).

DISCUSSION

The aim of prevalence examinations was to grasp occurrence of clinical form of iodine withdrawal – goitre in calves inside defined cattle population. In assessment of the situation it is conspicuous that disease appeared near or directly in localities where increase of goitre was recorded, particularly in calves as reported and continuously registered also in incriminated period by other authors (Čada, 1988; Strnadová, 1996). Defined narrow regional character of syndrome is eliminated by news on occurrence of goitre in calves also in other localities the Czech Republic (Lávička, personal information, 1996).

Without a possibility to use official statistics, further domestic comparison is complicated. It cannot overlook that in field screenings not uniform approaches to problems were observed together with diagnostic mistakes and incorrect conclusions. In interest of early finding of disease and use of efficient sanitation measures, it is topical to place a special emphasis on the task of complex procedure, to consider results of goal-directed epizootological analysis, to perceive deviations in thyroid gland (Tab. I) and to orient attention to dissection and laboratory examinations.

Local frequency in different herd fluctuated from 1 to 100%, in three herd all 66 calves have been afflicted by the disease, which were born in time when the disorder has been flared up. Compared with primary information of Čada (1985) who mentions sporadic occurrence, we recorded mass sickness rate, spread by further concomitant phenomena.

IV. Iodine content in milk of dairy cows in breedings with occurrence of the goitre ($\mu\text{g.l}^{-1}$)

Agricultural enterprise	<i>n</i>	\bar{x} ($\mu\text{g.l}^{-1}$)	$s_{\bar{x}}$ ($\mu\text{g.l}^{-1}$)
Sv	12	20.5	6.5
So	10	≤ 10	
Kř	6	30.8	4.5
Fr	5	30.5	1.7
St	18	25.5	4.6
Hl	28	25.3	3.6
Ja	24	25.0	4.1
Ne	18	28.1	7.7
Sk	24	14.2	5.0
Me	6	20.1	2.6
Vo	16	15.2	10.9

V. Distribution of frequency of average iodine values in milk of dairy cows from breedings with occurrence of the goitre in new-born calves (A) and from breedings without clinical finding on thyroid gland (B)

Health condition	Number of breedings	Iodine content in milk ($\mu\text{g.l}^{-1}$)			
	<i>n</i>	10–20	20–30	30–40	40–80
Occurrence of goitre (A)	11	18.5%	63.0%	18.5%	0%
Without occurrence of goitre (B)	40	5%	47.5%	30%	17.5%

Health consequences in reproduction were also significant. Occurrence of abortions and higher percentage of precocious parturitions with dead foetuses, as well as higher death rates of calves, hypotrophy and depression of growth of calves. Identical findings as a consequence of maternal deficiency of iodine in calves has been reported by Wilson (1975); disorders of puerperium with prolonged involution of sexual organs are accompanied by increased occurrence of endometritides (McDowell, 1992). In goats feed ration with low iodine content (0.11 mg/kg of feed dry matter) also lower percentage of conception after first insemination and prolongation of length of gravidity (Groppel, 1993).

If prevalence of goitres could have been used as a criterion for evaluation of iodine abundance in population (Hníková, 1995) and to take into ac-

count that dairy cows whose calves were afflicted with goitre exhibited lower milk production by 21% (Groppel et al., 1986a, b), we will obtain more concrete view of economic impacts of the disease which challenge urgent redress. Inhibitory effect of iodine withdrawal on milk efficiency has been found earlier; experimentally induced block of thyroid gland, e.g. reduced lactopoiesis by 50–80% and vice versa, supplement of iodinated casein to breeding dams with hypofunction of thyroid gland increased their milk yield (Miller et al., 1967).

The relationship between occurrence of goitre in calves and low iodine content in milk of their mothers confirms the known dependence between intake of iodine and its content in tissues, urine and milk (Groppel, 1993; Herzig et al., 1996a, b). Regarding these facts, it is highly topical to compare the development of findings of iodine content in cow milk in the Czech Republic. In the 80s when e.g. in Moravia iodine levels in milk ranged from 140 to 225 $\mu\text{g.l}^{-1}$ (Šucman et al., 1994), average iodine content in south-Bohemian breedings reached 62.5 or 100 $\mu\text{g.l}^{-1}$, resp. (Brožová, 1985).

The latter findings register the situation with relatively rich administration of commercial production feed mashes and mineral additives iodine-supplemented. Moreover, inlet of iodine into the body was not limited only by peroral intake, because iodine-containing preparations were used for disinfection of mammary gland, namely Jodonal (Vlčková, 1986). Symptoms of iodopenias were not observed (Kroupová, Brožová, 1986). Mass occurrence of goitre in new-born calves is bound to later years. Original phenomenon of fast incidence of pathological findings on thyroid gland is a critical reduction of iodine content in milk. Among reasons of morbidity are: restricted consumption of commercial feed mashes, dictated by economic instability of enterprises, exclusive administration of cereal meals of domestic provenance without enrichment by iodine and areal replacement of Jodonal by the preparation Benzitrin, not containing iodine (Kursa et al., 1994). Vyháňková et al. (1994) reported on significant influence of iodine content in milk using iodophore preparations to wash the udders. The effect of percutaneous resorption of iodine after application of Jodonal on mammary gland with subsequent statistically significant increase of iodine level in milk and urine of cows was verified experimentally (Herzig et al., 1996a, b).

Successful substitutive therapy and metaphylaxy by iodine-containing preparations confirmed the prerequisite that arisen congenital goitre is a manifestation of decreased function of thyroid gland connected with deficiency of iodine in feed ration of pregnant cows and heifers which was alternatingly deepened by further factors with strumigenic effect. It has been found earlier that except low iodine content in basic feed ration high content of nitrates

can be applied in feeds and drinking waters (Písaříková et al., 1996), administration of high rations of plants of the cabbage family, stressing factors and deficiencies in mineral nutrition (Kursa et al., 1994).

Experience presented in summary obtained from treatment of goitre are comparable with foreign data on soon retrogression of symptoms, on prevention of losses and prevention of further occurrence of goitre after metaphylactic intervention in pregnant dams (Flamann, 1978; Vrzgula et al., 1971; Kóňa, 1982; Körber, 1988; Bíreš et al., 1996b). Our knowledge correspond with opinions of supporters of therapy of simple goitre by iodine in human medicine; after Zamrazil (1995) therapy of goitre by preparations of identically efficient like administration of thyroxine.

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Received for publication on June 16, 1997

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Důsledky deficitu jódu u skotu v některých oblastech České republiky.

Scientia Agric. Bohem., 28, 1997 (2): 105–117.

Větší část České republiky je klasickým územím s nedostatkem jódu a s následným endemickým výskytem chorob z jeho deficitu. Neuspokojivá saturace jódem se vyskytuje i u hospodářských zvířat.

V terénních průzkumech uskutečňovaných v letech 1988–1997 v chovech skotu v osmi okresech jihozápadních Čech byl zjišťován výskyt klinických forem karence jódu, projevujících se u telat zvětšením štítné žlázy – strumou. Diagnostický postup zahrnoval analýzu chovatelských podmínek a anamnestických údajů, klinická vyšetření a pitvy uhynulých a nutně poražených jedinců. Palpační nálezy na štítné žláze byly podle klasifikačních kritérií zařazeny do pětistupňové řady (tab. I). Souběžně byl monitorován obsah jódu v mléce dojníc. K jeho stanovení bylo použito alkalické

spalování suchou cestou a následné kolorimetrické stanovení podle Sandel-Kolthofa (Bednář et al., 1964). K terapii a metafylaxi strumy byly použity roztoky jodidu draselného, Lugolův roztok a přípravek Intrajodin.

Na 25 farmách bylo klinicky vyšetřeno 1 355 telat ve věku 1 až 21 dnů (tab. II a III). U 404 jedinců (tj. 29,8 %) byla zjištěna výrazně zvětšená štítná žláza, u 63 telat (4,6 %) byl palpační nález neurčitý a u 888 telat (65,5 %) negativní. Telata se rodila v horší kondici, málo životaschopná, někdy mrtvá. Frekvence nálezů v jednotlivých stájích kolísala (1–100 %).

Velikost strumy byla variabilní. Extrémní hmotnost strumózní štítné žlázy (720 g) odpovídá až 70násobku normální štítné žlázy u telat stejného věku. Zvětšená štítná žláza komplikovala průběh porodů, tlakem na hrtan a průdušnici způsobovala po narození dušnost, vedoucí v prvních hodinách života i k exitům, a ztěžovala příjem tekutin a krmiv. Oběhové ústrojí vykazovalo arytmii, labilitu pulzu, městnání v oblastech artérií *carotis* a předních dutých žil. U 10 % případů byla zaznamenána místní olysalost na hýždích, bocích a v okolí mluce. Generalizovaná *alopecia congenita* byla zjištěna u dvou jedinců spolu s vyklenutím frontální části neurokrania. Při pitvách byly zjištěny rosolovitě podkožní infiltráty, zvětšení štítné žlázy (velikost až 15 x 20 cm), povrch uzlovitého vzhledu (obr. 2) a trubicovité rozšíření krkavic a předních dutých žil.

Koncentrace jódu v mléce dojníc ve stájích s výskytem strumy se pohybovala od 10 do 30,8 $\mu\text{g}\cdot\text{l}^{-1}$, což svědčí o deficitním příjmu jódu u matek v průběhu gravidity (tab. IV). Tyto hladiny byly významně nižší oproti obsahu jódu v mléce krav bez nálezů strumy u jejich potomstva – v průměru 40 $\mu\text{g}\cdot\text{l}^{-1}$ (tab. V).

V práci jsou diskutovány příčiny vzniku jodopenie a následné morbidity. Jsou uváděny do souvislosti se zkrmováním objemných krmiv a obilních šrotů výhradně místní provenience bez obohacování jódem. Úspěšná terapie a metafylaxe strumy přípravky obsahujícími jód (kalium iodatum, Lugolův roztok, Intrajodin) potvrdila tyto závěry.

Karenci jódu mohly prohlubovat vyšší obsahy dusičnanů v krmivech a v pitné vodě a přítomnost brukvovitých rostlin v krmných dávkách.

dojnice; mléko; telata; štítná žláza; patologie; struma; diagnostika; terapie

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