The content of iodine in pork

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ABSTRACT: The present study brings current information on providing market pigs and sows with the required iodine level up to date. The results were obtained by the determination of the iodine content in leg muscles and by the relationship between those concentrations and the iodine intake by the human population. The iodine content was assessed by the Sandell-Kolthoff method in 108 samples of leg muscles (*m. gracilis*) of market pigs from 18 herds in 10 districts of the Czech Republic collected during the period April 2004 to August 2004. Average iodine content in leg muscles of market pigs was 25.6 ± 15.54 μg I/kg fresh matter, median 20.2 and coefficient of variation 60.6%. Significantly higher ($P < 0.05$ to $P < 0.001$) iodine levels were recorded in the leg muscles was of herds LI2, ZU, BR, FU, BU, ST and some others. Iodine level variations in the samples from respective farms were expressed in the levels range of 8.5 to 66.2 μg I/kg. The detected variations might have been caused by different iodine saturation of the pigs from different herds, their physiological requirement, manifestation of physiological ability of respective animals to utilize the iodine source, potential effect of goitrogens and environmental conditions. It is necessary to consider the iodine content in pork in the balance of the iodine supply in the shopping basket of consumers. Provided that the average annual consumption of pork is 40.9 kg with iodine content of 25.6 μg/kg (8.5 to 66.2 μg/kg), the average annual iodine intake is 1047 μg, which represents 1.4 to 2.4% of the required intake per person per year.

Keywords: iodine supplementation; iodine requirement

Over the two past decades, particular attention was concentrated on the iodine supplementation of the inhabitants of the Czech Republic. The initiative of human endocrinologists and hygienists to investigate the possibilities of how to increase the low iodine content in milk, meat and eggs and thus to extend the function and participation of food of animal origin in the prevention of iodine deficiency in humans was respected by veterinary and agricultural researchers (Kaufmann et al., l998 a,b). This group of foodstuffs are especially significant and non-substitutable under the conditions of the Czech Republic, with respect to their consumption and feeding behaviour of the consumers (Borkovcova and Rehurkova, 2001).

The iodine content in products of animal origin correlated with the levels of animal supplementation with this trace element. He et al. (2002) recorded a higher content of iodine in meat products from animals fed diets containing iodine salts or algae (*Laminaria digitala*) with higher iodine content. That was increased by 45%, 213%, 124% and 207% in fresh muscles, adipose tissues, heart muscles and liver, respectively. The iodine content in the urine of the supplemented groups of pigs was also increased. Experiments testing effectiveness of iodine supplementation of animal diets showed in similar results (Berg et al., 1988; Anke et al., 1994; Herzig et al., 1999). Goitrogens cause increase in the requirement of iodine. Feeding oilseed rape containing glucosinolates caused enlargement of thyroid gland (Schone, 1999).

In association with the evaluation of a ten-year-period of complex prophylaxis of iodine deficiency

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in the Czech Republic, we monitored the situation in food animal-derived products (Herzig et al., 1999, 2000, 2001).

The purpose of the present study was to survey iodine content in pig muscles before their processing in the food industry and thus to update information concerning optimum iodine intake by the human population.

MATERIAL AND METHODS

Iodine levels were determined in 108 samples of leg muscles (*m. gracilis*) of market pigs and sows from 18 randomly selected farms in 10 districts of the Czech Republic. The samples were collected after meat inspection in the slaughters of two meat-processing plants. During the period April 2004 to September 2004, six samples of muscles were collected from each selected farm. After obtaining samples, the researchers registered them in such a way so that the extramural anonymity of their origin may be observed, and they were kept frozen before analysis.

The iodine concentration of the muscle samples were assessed by a spectrophotometric method using alkaline incineration based on the Sandell-Kolthoff reaction (Bednar et al., 1964). The principle of the assessment is reduction of Ce^{4+} to Ce^{3+} in the presence of As^{3+} and the catalytic effect of iodine. Mineralization is performed in a dry alkaline environment at 600°C. By that method, the total iodine content is assessed, i.e. both inorganic and protein-bound iodine. The results obtained were evaluated by standard statistical methods. Average values ($\bar{x}$), standard deviation (± SD), variation coefficient (*V*%), median and statistical significance using the Tukey test were calculated (Motulsky, 1999).

RESULTS AND DISCUSSION

The average iodine content in pig muscles from respective herds is shown in Table 1. The iodine

Table 1. Iodine content (μg I/kg) in muscles of pigs from respective herds

Locality	District	*n*	Sex	Average	± SD	Median	*V*%
VY	Pelhrimov	6	market pigs	20.0	7.07	21.7	35.2
SL	Trebic	6	market sows	20.5	8.72	18.1	42.6
HA	Trebic	6	market sows	19.2	13.24	13.8	68.9
CH	Chrudim	6	market sows	16.3	5.46	17.4	33.6
SR	Chrudim	6	market pigs	8.5	7.56	9.0	80.7
JE	Znojmo	6	market sows	13.4	9.73	10.1	72.6
VK	Znojmo	6	market pigs	12.8	6.84	12.2	53.5
SA	Znojmo	6	market pigs	9.1	8.68	9.8	87.7
ME	Zdar n. S.	6	market pigs	13.9	6.31	15.9	45.5
SE	Jihlava	6	market sows	22.7	1.77	22.4	7.8
DU	Hodonin	6	market pigs	16.2	9.60	14.0	59.5
BR	C. Krumlov	6	market pigs	37.8	8.81	38.0	23.3
FU	C. Krumlov	6	market pigs	36.4	9.77	37.5	26.8
ZU	C. Krumlov	6	sows	49.2	15.98	54.4	32.5
LI1	Strakonice	6	sows	22.5	8.70	25.9	39.2
LI2	Strakonice	6	market pigs	66.2	26.01	68.6	38.7
BU	Prachatice	6	market pigs	39.2	9.40	37.4	24.0
ST	Prachatice	6	market pigs	37.7	6.22	39.1	16.5
Average				25.6	15.54	20.2	
V%				60.6			

level variations in the samples from respective farms were expressed by the variation range from 8.5 to 66.2 μg I/kg. The average iodine level in leg muscles of market pigs from the investigated herds was 25.6 ± 15.6 μg I/kg fresh matter, median 20.2 and coefficient of variation 60.6%.

Significantly higher ($P < 0.05$ to $P < 0.001$) iodine content was recorded in herds LI2, ZU, BR, FU, BU, ST and some others (Table 2). Based on the detected values, the herds can be assigned into three categories (Figure 1) with average iodine content of <25, 25 to 50 and >50 μg I/kg, respectively. Categories 1, 2 and 3 contained 66.6%, 27.8% and 5.6% of the total number of herds, respectively. Minimum and maximum values, median and 25% and 75% percentiles are also presented.

The values obtained in the present study samples from two-thirds of herds were lower than 25 μg I per kg. These were comparable with those reported by Velisek (1999) who found iodine content in pork between 9 and 16 μg/kg. One-third of herds showed higher values; the value 66.2 μg/kg was exceptional. Higher values were recorded in pigs from three districts (Cesky Krumlov, Strakonice and Prachatice), which might have indicated a higher iodine concentration in mineral supplements.

Optimum iodine supplementation in the diet is highly important not only for maintaining good health of farm animals, but also from an aspect of required iodine content in foodstuffs of animal origin for human nutrition. Delange (1993) recommended 90–120, 150 and 200 μg iodine·per day for children, adults and pregnant and lactating women, respectively. From that aspect, it is also necessary to consider iodine content in pork in the balance of iodine supply in the shopping basket of consumers. Provided that the average annual consumption of pork in the Czech Republic is 40.9 kg (Pavlu, 2003) with the iodine content of 25.6 μg/kg (8.5 to 66.2 μg/kg), the iodine intake is 1047 μg, which represents 1.4 to 2.4% of requirement of the men per year. These figure show that pork does not provide a significant amount of iodine to the human diet.

Milk, meat and egg iodine content vary relative to a number of factors; animal supplementation with diet is essential. Iodine deficiency in food-

Table 2. Statistical significance differences of iodine content in muscles of pigs among the individual herds

	VY	SL	HA	CH	SR	JE	VK	SA	ME	SE	DU	BR	FU	ZU	LI1	LI2	BU	ST
VY	♦													**		***		
SL		♦												**		***		
HA			♦											***		***		
CH				♦										**		***	*	
SR					♦							**	**	***		***	***	**
JE						♦						*	*	***		***	**	*
VK							♦					*	*	***		***	**	*
SA								♦				**	**	***		***	***	**
ME									♦			*	*	***		***	*	*
SE										♦				**		***		
DU											♦			***		***	*	
BR												♦				**		
FU													♦			***		
ZU														♦		**		
LI1															♦	***		
LI2																♦	**	**
BT																	♦	
ST																		♦

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$

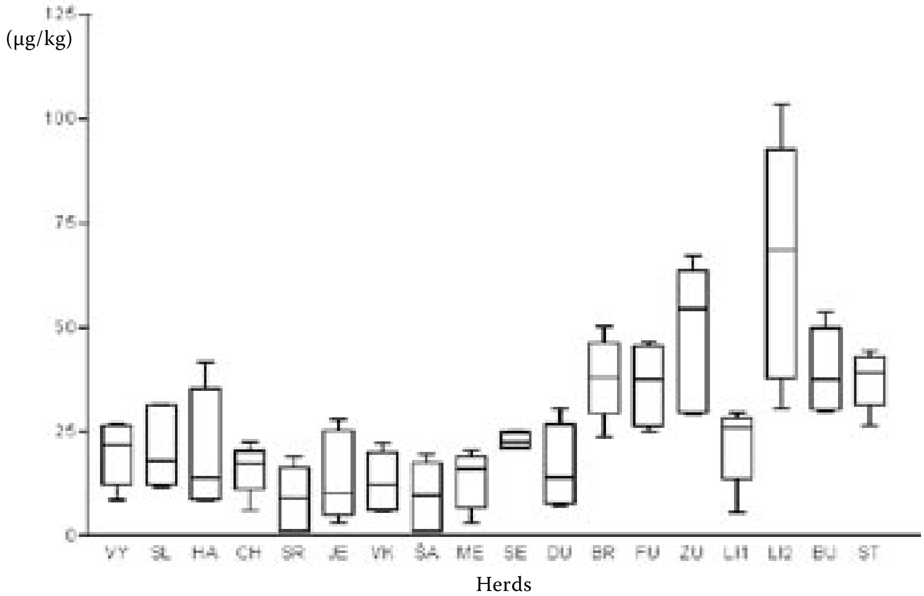

Figure 1. Iodine content in muscles of pigs from the individual herds, characterized by minimum and maximum values, median and 25% and 75% percentiles

stuffs results from low iodine content in soil and consequently in feeds, undervaluation of the role of minerals in the nutrition of farm animals, effect of natural goitrogens and those coming from pollution caused by the activity of the men and some other factors, e.g. selenium deficiency.

Based on the well-known fact that iodine content in meat and milk is associated with the level of iodine supplementation of animals, the detected variability of findings indicates differences in iodine supplementation of pigs in the Czech Republic. Despite the sampling places were randomly selected, numbers of examinations were relatively limited by the extent of financial subventions and capacity of the laboratory, we can consider our results as representative.

The total content in the diets of food animals is particularly affected by the quality of synthetic supplements. Scientific information, qualified impulses, the wide offer of mineral feed supplements containing iodine and the interest of the farmers resulted in the process of general iodine supplementation in the mid-1990s. Easily controllable iodine intake by the animals and iodine content in food of animal origin by the additives was experimentally demonstrated by Convey et al. (1977), Anke et al. (1989), Pennington (1990) and Herzig et al. (1999). The use of iodine additives reflects both in optimization of thyroid gland function and iodine deposition in the internal organs, musculature and its secretion through milk. These also demonstrated that the problem of iodine deficient diets derived from the above mentioned constant conditions is unresolvable without compulsory iodine supplementation. Some farmers still undervalue the significance and implications of these measures. Primarily, attention is not given to other, less recognised consequences of iodine deficiency such as reproductive dysfunctions, with reduced subsequent efficiency without diagnosed causes.

However, in any case, it is necessary so that the farmers primarily accept the presented findings. It is particularly topical to control supplementation of feed rations with the additives containing iodine according to the physiological requirements and production conditions. It seems to be suitable to keep at systematic general monitoring of iodine content in foodstuffs of animal origin with the possibility of feedback to the agribusiness (Kursa et al., 2005).

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