THE EFFECT OF FEEDING EXTRACTED RAPESEED MEAL ON THE CONTENT OF IODINE IN MILK, URINE AND BLOOD PLASMA IN DAIRY COWS

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Abstract: The study was aimed at validating the influence of increased intake of extracted rapeseed meal (4.7 kg/cow/day) on the distribution of iodine in various body fluids (blood plasma, urine and milk) in groups of dairy cows. The feed ration contained 1.2 mg iodine/kg of dry matter (i.e. additive iodine – inorganic form) in the 1st stage of experiment, 0.6 mg iodine/kg of dry matter (i.e. additive iodine – inorganic and organic form) in the 2nd stage. The average contents of iodine in milk and urine were: 33.1µg/l and 192.9 µg/l in 1st stage of experiment, 79.6 µg/l and 376.3 µg/l in 2nd stage. Our results show that an increased intake of extracted rapeseed meal reduces utilization of iodine (iodine in milk) and increases urinary iodine excretion. Our results also show that organic form of iodine was effectively utilized.

Key Words: strumigens, iodine, milk, urine, blood plasma

INTRODUCTION

Screening the values of iodine in feed rations in farmed animals and also in animal products is important because of the risks that presents themselves from the abnormal intake of such. Not only in the past but also today, people as well as animals’ suffering from the lack iodine has been a worldwide issue. This problem is solved by the International council for the control of iodine deficiency disorders (ICCIDD) and Interdepartmental commission for the solution iodine deficiency in the Czech Republic. The question of iodine deficit is still in the forefront of interest of not just medical professionals but also by the manufactures of mineral additives, feeding mixtures, cooking salt, food in general and last but not least the breeder animals. Schöne et al. (2009) recommend 0.5–1.5 mg iodine per kg dry matter (DM) feed ration.

Extracted rapeseed meal (ERM) is commonly used in animal nutrition as protein source. Limiting factor of this crop is the content of glucosinolates. Glucosinolates can be hydrolysed by the enzyme myrosinase to release products with goitrogenic effects that interfere with iodine metabolism and therefore affect the functioning of the thyroid gland and consequently with the animal performance (Mejicanos 2016). Tripathi and Mishra (2007) states that fission products of glucosinolates lead to the decrease of iodine secretion through milk and to the increase of urine excretion. Except strumigenous effect, these substances have a negative effect on the feed taste, which leads to the decrease in consumption. This is the reason why the content of rapeseed products is limited in feeding mixtures. For example, Šimek et al. (2001) states, that 3–5% share of rapeseed meal in feeding mixture does not affect the taste of the feed. Recommended maximum daily intake of ERM is 2.5 kg/cow/day with maximal glucosinolates content up to 20 mmol/kg (Zukalová and Vašák 2001).

The aim of this study was to validate the effect of higher share of extracted rapeseed meal on the content of iodine in individual samples of blood plasma, urine and milk in Holstein breed cows.
MATERIAL AND METHODS

The 5 months experiment was conducted on a farm in the district Klatovy. The experiment included a total of 9 Holstein Friesians cows in their second lactation (average age of cows: 42 months). The average milk production was 36 kg/day. The study was divided into 2 phases. In the first phase (two months) the inorganic iodine was supplemented as *Kalium iodatum* (1.2 mg iodine/1 kg DM of feed ration). In the second phase (three months), the inorganic iodine was reduced on 50% and the organic iodine (10%) was added. In the second phase was 0.6 mg iodine/1 kg DM of feed ration. In both phases of the experiment, the animals received higher amount of extracted rapeseed meal (4.7 kg/cow/day). The composition of feed ration and iodine concentration are shown in the Table 1 and Table 2.

Samples of body fluids (blood, milk and urine) were collected every month from January to May. The blood samples were taken 2 hour after morning meal. Blood was collected from the *Vena caudalis mediana* into heme sampling tubes with heparin. Urine samples were collected by catheterizing the bladder to sterile tubes. Individual milk samples were collected from the complete milking into a set of sterile tubes (100 ml) by milking directly into the tubes to avoid contamination and stored at -20 °C. In total, 45 blood samples, 45 urine samples and 45 milk samples were collected.

The iodine content in the body fluids was determined by a modified colorimetric method (Sandell and Kollhoff) after alkaline ashing of the material (Bednář et al. 1964). The variation was assessed by using the one-way analysis of variance (ANOVA). All data were analysed using STATISTICA CZ 12 software (StatSoft Inc.).

Table 1 Composition of the diet of dairy cows

<table>
<thead>
<tr>
<th>Feed</th>
<th>Quantities of feed (kg)</th>
<th>DM (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass silage middle blossom</td>
<td>34.00</td>
<td>12.58</td>
</tr>
<tr>
<td>Wheat grain</td>
<td>6.80</td>
<td>6.05</td>
</tr>
<tr>
<td>Corn grain cracked</td>
<td>0.50</td>
<td>0.44</td>
</tr>
<tr>
<td>Urea 45% N</td>
<td>0.12</td>
<td>0.12</td>
</tr>
<tr>
<td>Extracted rapeseeds meal a</td>
<td>4.70</td>
<td>4.42</td>
</tr>
<tr>
<td>Soybean meal 48</td>
<td>0.72</td>
<td>0.64</td>
</tr>
<tr>
<td>Limestone</td>
<td>0.35</td>
<td>0.35</td>
</tr>
<tr>
<td>Mineral supplement</td>
<td>0.35</td>
<td>0.33</td>
</tr>
<tr>
<td>Salt-white</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td><strong>Totals by weight</strong></td>
<td><strong>47.62</strong></td>
<td><strong>25.46</strong></td>
</tr>
</tbody>
</table>

Legend: DM – dry matter; a glucosinolate concentration 18.1 mmol/kg;

Table 2 Concentration of iodine in various stages of the experiment

<table>
<thead>
<tr>
<th>Stage of experiment</th>
<th>Iodine concentration (mg/kg DM)</th>
<th>Concentration of iodine in feed ration (mg/kg DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>bulk and grain feed</td>
<td>Mineral supplement</td>
<td></td>
</tr>
<tr>
<td>1(^{st}) phase of experiment (2 months)</td>
<td>0.15</td>
<td>1.05</td>
</tr>
<tr>
<td>2(^{nd}) phase of experiment (3 months)</td>
<td>0.15</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Legend: DM – dry matter;

RESULTS AND DISCUSSION

The concentration of iodine in blood plasma samples

Physiological concentration of iodine in the plasma ranges from 40 µg/l to 110 µg/l (Špakauskas 2008). The average concentration of iodine in the blood plasma of dairy cows in our experiment
corresponds to sufficient iodine supply (Figure 1). The rise of iodine concentration \((p<0.01)\) in the third month of the second phase of experiment \((136.5 \pm 24.8 \text{ mg/l})\) is probably related to the higher utilization of iodine from organic sources (Bekeová 1998).

**Figure 1** Concentration of iodine in blood plasma samples in 1\textsuperscript{st} and 2\textsuperscript{nd} phase of experiment

All results are expressed as mean ± (SD); \(e:a, e:b, e:c, e:d\) \((p<0.01)\).

**The concentration of iodine in urine samples**

The dynamics of iodine concentration in urine is shown in Figure 2. The average iodine concentration in urine in both phases of the trial (1\textsuperscript{st} phase: 163.8 ± 61.5 \(\mu\text{g/l}\), 2\textsuperscript{nd} phase: 250.0 ± 146.4 \(\mu\text{g/l}\)), from diagnostic view, signalled satisfactory saturation of iodine in milking cows. According to Herzig et al. (1996) recommended values of iodine in excreted urine should be higher than 100 \(\mu\text{g/l}\).

**Figure 2** Concentration of iodine in urine samples in 1\textsuperscript{st} and 2\textsuperscript{nd} phase of experiment

All results are expressed as mean ± (SD); \(e:a, e:c, e:d\) \((p<0.05)\); \(e:b\) \((p<0.01)\).
The concentration of iodine in milk samples

The physiological range of iodine concentration in milk is 100–200 µg/l (Schöne et al. 2009). The iodine milk concentration was under the physiological values during the whole experiment. According to Trávníček et al. (2011), the values of iodine concentration under 100 µg/l in milk related with low levels of the element intake. Low iodine values in milk indicate the negative effect of increased extracted rapeseed meal in feed ration on the iodine metabolism. Also Franke et al. (2009) proved that when feeding rapeseed oil, the iodine concentration in milk decreases by two thirds.

In the case of higher intake of rapeseed product in feed ration, it is recommended to increase the iodine to 2–3 mg/kg DM (Flachowsky et al. 2014). As our results show, it would also be possible to substitute inorganic iodine form by organic one (Figure 3).

**Figure 3 Concentration of iodine in milk samples 1st and 2nd stage of experiment**

All results are expressed as mean ± (SD); e:b (p˂0.05); e:a, e:c, e:d (p˂0.01).

**CONCLUSION**

Our results show that the increased intake of extracted rapeseed meal (glucosinolates) increases the secretion of iodine via kidneys instead of milk gland. For that reason, the diagnostic method of validation of the iodine concentration in urine or milk, as an iodine saturation parameter, level is considerably limited.

**ACKNOWLEDGEMENTS**

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