The Use of Rapeseed-oil Cake in the Rations of Farmed Red Deer (Cervus elaphus)

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Abstract. The study was carried out to determine the effects of feeding rapeseed oil cake to farmed red deer (Cervus elaphus) over the winter period thus replacing the traditional ration of rolled grain of the equivalent feed value. It was found that rapeseed oil cake ration of 0.2 kg per day per animal over the winter period increased the level of fatty acids ω-3 by 11.28%, ω-6 fatty acids by 15.13% of the total lipids in meat in comparison with the control group. The amount of the total feed consumed in the experimental group decreased by 3.2% per animal and the feed costs were lower by 8.13% in comparison with the control group. From the data obtained it can be concluded that the use of rapeseed cake in feeding of farmed red deer is economically cost-effective.

Key words: deer, economy, meat quality, rapeseed oil cake

INTRODUCTION

Unconventional animal husbandry sectors as well as the generally accepted animal husbandry sectors have become more important in Latvia. The breeding of wild animals including deer is prospectively one of the most rapidly growing and non-conventional livestock sub-sectors in Latvia. One of the goals of deer breeding is the acquisition of high quality venison in the greatest possible quantities, as the main source of income in deer breeding is meat production (Fletcher, 1989). Animal-keeping conditions in deer breeding are similar to those of wildlife. Deer live outside throughout the year and are kept in herds in enclosed territories or pasture–grounds. In winter, red deer are subject to weather impacts that slow down their metabolism. Consequently, adult animals in winter lose up to 20% of their bodyweight (Fletcher, 1989; Paegličētis et al., 2006; Tuckwell, 2003). Therefore to maintain red deer body weight over the winter season dietary requirements include red deer feeding by full value feed ensuring that according to the norms, an animal weighing 150–200 kg intakes feed containing 2.6–2.7 kg of dry matter, 320.0–330.0 g of protein, and 25.0–39.0 MJ exchange energy amount on average per day (Fletcher, 1989; Adam, 1994). The above feed value in Latvia is ensured by feeding daily on the average 7 kg haylage and 1 kg rolled grain (oats, etc.) per animal.

The data from the scientific sources indicate that overseas red deer farmers enrich winter rations with high protein fish meal (Adam, 1994; Tuckwell, 2003). A similar option may be used in Latvia by applying rapeseed oil cake during the winter. Rapeseed oil cake is characterized by high nutritive value and is composed of
approximately 35.0–45.0% crude protein, 14.0–15.0% crude fat, 7.27 MJ kg
metabolizable energy, 8.0–9.0% omega–3 (ω–3), 20.0–24.0% omega–6 (ω–6) fatty
acids of the total lipids. Locally produced rapeseed oil cake contains slightly less
protein in comparison with fish meal, however, the amount of ω–3 and ω–6 fatty acids
is the same.

As a component of the food ration traditionally used for farmed red deer, rapeseed
oil cake can successfully replace a relevant amount of grain. To provide the required
protein and energy levels, optimum rapeseed cake feeding schemes have been
elaborated for cattle, pigs and poultry. The results of the research studies carried out at
Research Institute Sigra indicate that 5% rapeseed oil cake supplement has no
influence on the sensory quality of either meat, milk or eggs, while providing a
favorable impact on the productivity of farmed animals as well as expediting the level
of ω–3 and ω–6 fatty acids in milk, meat or eggs. In scientific sources there are no
detailed references available on feeding rapeseed oil cake to farmed red deer and its
impact on the meat quality.

The objective of our study was to determine the influence of the rapeseed oil cake
on meat quality and to assess the economic cost–effectiveness of rapeseed oil cake in
winter diets of red deer.

MATERIAL AND METHODS

The feeding trial with rapeseed oil cake was performed with red deer (Cervus
elaphus) farmed in captivity and enclosed territories from January-April, 2010. The
snow cover in the confined area (pasture ground) was on average 53 cm and the
average air temperature was −5.6°C, which was 0.7°C degrees lower than the norm
(Meteorology Centre, 2010).

The trial included two groups of red deer of identical age: group 1–the control
group and group 2–the trial group. Each group consisted of 10 animals. Both groups of
deer received feed of the same value. The content of feed ration was balanced
corresponding to the season and norms of physiological needs for the red deer
organism, so every animal could daily intake 2.6 kg of dry matter (DM), containing
320.7 g of crude protein (CP). The feed value is ensured by feeding 7 kg haylage and 1
kg rolled grain (oats) per animal per day. The trial group of red deer received 0.2 kg of
rapeseed oil cake, which was used to replace an amount of protein and dry matter equal
to that of rolled grain. Thus, the trial group received 0.2 kg of rapeseed oil cake in
place of 0.450 kg rolled grain in comparison with the control group.

The content of fatty acids in red deer meat was similarly evaluated. Previously
homogenized meat samples were prepared for GLC (gas–liquid chromatography)
analysis using direct saponification with KOH methanol followed by a derivatization
with (trimethylsilyl) diazomethane by the method of Aldai (Aldai et al., 2006). An
ACME, model 6100, GLC (Young Lin Instrument Co) equipped with a flame
ionization detector, an automatic sample injector, and an Alltech AT–FAME analytical
column (fused silica 30m × 0.25 mm i.d.) was used. As the carrier gas He was used
with a flow rate of approximately 2 mL min⁻¹. The temperature condition of the oven,
injector and detector was the same as in the method of Aldai et al. (2006). Results were
evaluated with a conventional integrator program (Autochro–2000, Young Lin
The individual FAMEs (fatty acid methyl esters) were identified according to similar peak retention times using standard mixture Supelco 37 Component FAME Mix.

The economic efficiency assessment of feed ration containing rapeseed oil cake included the determination of feed consumption by one deer and calculation of costs for the consumed feed.

Research data were analyzed by a non-parametric method (Mann–Whitney U criteria test) for data comparison (Arhipova & Báliņa, 2006). Two independent variables – deer of control group \(n_1 = 10\) and deer of trial group \(n_2 = 10\) – were compared at the essentiality level \(\alpha = 0.01\).

RESULTS AND DISCUSSION

The economic cost effectiveness of adding rapeseed oil cake to red deer rations was assessed by amount of feed consumption, feed costs and protein content in daily feed. When using rapeseed oil cake as a feed ingredient for farmed red deer, daily feed consumption per animal per day was 7.750 kg, or by 0.250 kg or 3.2% less than per one animal in the control group.

The costs of the feed consumed by one animal receiving rapeseed oil cake was by 8.13% lower than the same costs for the control group. The difference in costs was related to the protein content in rolled grain and rapeseed oil cake. Rolled grain (oats) contained on the average 14.64% protein (DM) and rapeseed oil cake – 29.82% protein (DM). One kg protein in the form of rolled grain costs 0.820 LVL, while in the form of rapeseed oil cake – 0.570 LVL. The difference of protein costs per kg is 0.250 LVL. Thus the protein costs of rapeseed oil cake origin are lower than those of the rolled grain origin, consequently, the use of rapeseed oil cake as a feed ingredient in the ration of farmed red deer is more cost effective. In the feed ration for the trial group, the amount of 0.200 kg rapeseed oil cake (0.034 LVL) was used to replace 0.450 kg rolled grain (0.054 LVL) and resulted in savings of 0.020 LVL ration per deer.

Table 1. Economic cost effectiveness from rapeseed oil cake in red deer ration (according to trial data).

<table>
<thead>
<tr>
<th>Item</th>
<th>Group 1 - control</th>
<th>Group 2 - trial</th>
<th>Deviation to control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed ingredient:</td>
<td></td>
<td></td>
<td>Bias</td>
</tr>
<tr>
<td>haylage, kg per day*</td>
<td>7.00</td>
<td>7.00</td>
<td>-</td>
</tr>
<tr>
<td>rolled grain, (oats) kg per day*</td>
<td>1.00</td>
<td>0.550</td>
<td>-0.450 – 45.0</td>
</tr>
<tr>
<td>rapeseed oil cake, kg per day*</td>
<td>-</td>
<td>0.200</td>
<td>+0.200 +100.0</td>
</tr>
<tr>
<td>Total feed consumption, kg per day</td>
<td>8.00</td>
<td>7.750</td>
<td>-0.250 – 3.2</td>
</tr>
<tr>
<td>Feed costs:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>haylage, LVL per day*</td>
<td>0.126</td>
<td>0.126</td>
<td>-</td>
</tr>
<tr>
<td>rolled grain (oats), LVL per day*</td>
<td>0.120</td>
<td>0.066</td>
<td>-0.054 – 45.0</td>
</tr>
<tr>
<td>rapeseed oil cake, LVL per day*</td>
<td>-</td>
<td>0.034</td>
<td>+0.034 +100.0</td>
</tr>
<tr>
<td>Total feed costs, LVL per day</td>
<td>0.246</td>
<td>0.226</td>
<td>-0.020 – 8.13</td>
</tr>
<tr>
<td>Costs of feed utilised over the trial</td>
<td>22.14</td>
<td>20.34</td>
<td>-1.80 – 8.13</td>
</tr>
<tr>
<td>period on the average, per animal LVL</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* The prices are calculated according to 2009 Prices Roundup provided by LR Central Statistics Bureau.
The costs of the feed used per one animal in the trial group were on average 20.34 LVL which is 8.13% lower than for the control group. The savings of the feed utilised on average per animal over the trial period were 1.80 LVL in comparison with the control group. It can be concluded that the use of rapeseed oil cake in red deer feed is economically cost effective.

A quality concept in food production is defined as the quality set of the product based on the property’s ability to satisfy consumer needs. As it is known, product quality, consumers’ satisfaction and enterprise profitableness are mutually closely connected factors. Higher quality indices create higher consumer satisfaction, by allowing the sale of products at significantly higher prices (Kotlers, 2006). Deer meat quality has an essential role in the deer breeding bio–economy determining its market niche and product prices.

Table 2. Composition of fatty acids in the meat of deer (% of total lipids).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Group 1 - control</th>
<th>Group 2 - trial</th>
<th>Deviation to control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saturated fatty acids (SFA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myristic acid C_{14:0}</td>
<td>5.32</td>
<td>1.24</td>
<td>−4.08</td>
</tr>
<tr>
<td>Palmitic acid C_{16:0}</td>
<td>19.43</td>
<td>11.91</td>
<td>−7.52</td>
</tr>
<tr>
<td>Margaric acid C_{17:0}</td>
<td>0.60</td>
<td>0.41</td>
<td>−0.19</td>
</tr>
<tr>
<td>Stearic acid C_{18:0}</td>
<td>18.67</td>
<td>14.20</td>
<td>−4.47</td>
</tr>
<tr>
<td>Total</td>
<td>44.02</td>
<td>27.76</td>
<td>−16.26</td>
</tr>
<tr>
<td>Monounsaturated fatty acids (MUFA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palmitoleic acid C_{16:1}</td>
<td>3.80</td>
<td>1.73</td>
<td>−2.07</td>
</tr>
<tr>
<td>Oleic acid C_{18:1} cis n-9</td>
<td>6.75</td>
<td>15.38</td>
<td>+8.63</td>
</tr>
<tr>
<td>Elaidinico acid C_{18:1} trans n-9</td>
<td>3.34</td>
<td>2.87</td>
<td>−0.47</td>
</tr>
<tr>
<td>Total</td>
<td>10.09</td>
<td>19.98</td>
<td>+9.89</td>
</tr>
<tr>
<td>Polyunsaturated fatty acids (PUFA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linoleic acid C_{18:2} cis n-6</td>
<td>13.10</td>
<td>27.22</td>
<td>+14.12</td>
</tr>
<tr>
<td>Alpha - linolenic acid (ALA) C_{18:3} n-3</td>
<td>2.56</td>
<td>4.83</td>
<td>+2.27</td>
</tr>
<tr>
<td>Eicosadienoic acid C_{20:2}</td>
<td>0.31</td>
<td>0.51</td>
<td>+0.20</td>
</tr>
<tr>
<td>Eicosatrienoic acid C_{20:3} n-6</td>
<td>0.19</td>
<td>1.00</td>
<td>+0.81</td>
</tr>
<tr>
<td>Eicosatrienoic acid C_{20:3} n-3</td>
<td>5.65</td>
<td>11.41</td>
<td>+5.76</td>
</tr>
<tr>
<td>Eicosapentaenoic acid C_{20:5} n-3 (EPA)</td>
<td>1.58</td>
<td>4.83</td>
<td>+3.25</td>
</tr>
<tr>
<td>Total</td>
<td>23.39</td>
<td>49.80</td>
<td>+26.41</td>
</tr>
<tr>
<td>Quality indices of fatty acids</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ratio amount saturated and polyunsaturated fatty acids</td>
<td>1.88 : 1</td>
<td>0.56 : 1</td>
<td>-</td>
</tr>
<tr>
<td>Total ω–3 fatty acids</td>
<td>9.79</td>
<td>21.07</td>
<td>+11.28</td>
</tr>
<tr>
<td>Total ω–6 fatty acids</td>
<td>13.60</td>
<td>28.73</td>
<td>+15.13</td>
</tr>
<tr>
<td>Σ ω–6 : Σ ω–3</td>
<td>1.38 : 1</td>
<td>1.36 : 1</td>
<td>-</td>
</tr>
</tbody>
</table>
The quality of deer meat is basically determined by the ratio of the content of fatty acids. At the end of the trial period, the content of fatty acids was evaluated using similar determinations in the meat of red deer. The meat of red deer fed with rapeseed oil cake contained about 27.76% saturated, 19.98% monounsaturated and 49.80% polyunsaturated fatty acids of total lipids (Table 2).

The relevant differences were observed by comparing both groups’ results, therefore it was important to determine the statistical significance of these differences. The Mann-Whitney U-test is used to determine if a difference exists between independent variables – deer of control group \( (n_1 = 10) \) and deer of trial group \( (n_2 = 10) \) (formula 1).

\[
U_i = n_1 \times n_2 + \left( n_i(n_i + 1)/2 \right) - \sum_{j=1}^{n_i} R_{ij}
\]

where: \( i = 1,2; n_1, n_2 – \) sample size; \( R_{ij} – \) the sum of the ranks. The smaller of \( U_1 \) or \( U_2 \) is compared to the critical value for the purpose of the test. Because the calculated \( U \) value in comparison with \( U \) critical value (formula 2) in all cases was smaller (formulas 4, 6, 8) it can be maintained that content of fatty acids essentially differ in the control and trial group deer meat composition.

\[
U_{\alpha(1)}; n_1; n_2 = U_{0.01;10;10} = 16
\]

Hence in comparison with the control group, with the use of rapeseed oil cake in the ration of farmed red deer, the content of fatty acids was significantly improved in meat as follows:

- decreasing the amount of saturated fatty acids (by 16.26%)  
  \[
  U_1 = 10 \times 10 + \left( 10 \times (10 + 1)/2 \right) - 143 = 12
  \]
  \[
  U = 12 < U_{0.01;10;10} = 16
  \]

- increasing the amount of monounsaturated fatty acids (by 9.89%)  
  \[
  U_1 = 10 \times 10 + \left( 10 \times (10 + 1)/2 \right) - 145 = 10
  \]
  \[
  U = 10 < U_{0.01;10;10} = 16
  \]

- increasing the amount of polyunsaturated fatty acids (by 26.41%)  
  \[
  U_1 = 10 \times 10 + \left( 10 \times (10 + 1)/2 \right) - 149 = 6
  \]
  \[
  U = 6 < U_{0.01;10;10} = 16
  \]

Under the influence of rapeseed oil cake, the amount of especially favourable \( \omega-3 \) fatty acids was increased by 11.28% and \( \omega-6 \) fatty acids – by 15.13% of the total lipid content. These fatty acids are not synthesized by the human organism; therefore, their consumption with food is necessary. \( \omega-6 \) fatty acid (linoleic acid) in a human body is
able to bind itself to cholesterol and reduce its amount (Field, 2003; WHO, 2003). The positive role of \(\omega-3\) (linoleic acid) and eicosapentaenoic acid in food is connected with their ability to inhibit a variety of risk factors causing cardiovascular and other diseases in humans.

Thus, it can be concluded that feeding rapeseed oil cake to red deer increased the level of fatty acids favourable to the human body and unavailable or scarcely available through food products.

**CONCLUSIONS**

The effectiveness of rapeseed oil cake as a feed ingredient for farmed red deer (*Cervus elaphus*) winter ration was evaluated in this study by replacing traditional rolled grain with rapeseed oil cake of equal feeding value. In comparison with the control group the amount of 0.2 kg of rapeseed oil cake per deer per day:

1. Improved the meat quality by increasing the contents of \(\omega-3\) fatty acids by 11.28%, \(\omega-6\) fatty acids by 15.13% of total lipids in meat;
2. Reduced the amount of the feed consumed on the average by 3.2% per deer and feed costs by 8.13%.

**REFERENCES**


