Agronomy Research **9** (Special Issue II) 455–460, 2011

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; Paeglītis 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 favourable 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

Instrument Co). 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 & Bāliņa, 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).

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

* 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).

Parameters	Group 1 - control	Group 2 - trial	Deviation to control
Saturated fatty acids (SFA)			
Myristic acid $C_{14:0}$	5.32	1.24	−4.08
Palmitic acid $C_{16:0}$	19.43	11.91	−7.52
Margaric acid $C_{17:0}$	0.60	0.41	−0.19
Stearic acid $C_{18:0}$	18.67	14.20	−4.47
Total	44.02	27.76	−16.26
Monounsaturated fatty acids (MUFA)			
Palmitoleic acid $C_{16:1}$	3.80	1.73	−2.07
Oleic acid $C_{18:1}$ cis n-9	6.75	15.38	+8.63
Elaidinic acid $C_{18:1}$ trans n-9	3.34	2.87	−0.47
Total	10.09	19.98	+9.89
Polyunsaturated fatty acids (PUFA)			
Linoleic acid $C_{18:2}$ cis n-6	13.10	27.22	+14.12
Alpha - linolenic acid (ALA) $C_{18:3}$ n-3	2.56	4.83	+2.27
Eicosadienoic acid $C_{20:2}$	0.31	0.51	+0.20
Eicosatrienoic acid $C_{20:3}$ n-6	0.19	1.00	+0.81
Eicosatrienoic acid $C_{20:3}$ n-3	5.65	11.41	+5.76
Eicosapentaenoic acid $C_{20:5}$ n-3(EPA)	1.58	4.83	+3.25
Total	23.39	49.80	+26.41
Quality indices of fatty acids			
Ratio amount saturated and polyunsaturated fatty acids	1.88 : 1	0.56 : 1	-
Total ω–3 fatty acids	9.79	21.07	+11.28
Total ω–6 fatty acids	13.60	28.73	+15.13
Σ ω–6 : Σ ω–3	1.38 : 1	1.36 : 1	-

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).

$$U_i = n_1 * n_2 + \left(n_i(n_i+1)/2\right) - \sum_{j=1}^{n_i} R_{ij} \quad (1)$$

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.

$$U_{\alpha(1);n1;n2} = U_{0.01;10;10} = 16 \quad (2)$$

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%)

$$\begin{aligned} U_1 &= 10*10 + \left(10*(10+1)/2\right) - 143 = 12 \\ U_2 &= 10*10 + \left(10*(10+1)/2\right) - 67 = 88 \end{aligned} \quad (3)$$

$$U = 12 < U_{0.01;10;10} = 16 \quad 4)$$

- increasing the amount of monounsaturated fatty acids (by 9.89%)

$$\begin{aligned} U_1 &= 10*10 + \left(10*(10+1)/2\right) - 145 = 10 \\ U_2 &= 10*10 + \left(10*(10+1)/2\right) - 65 = 90 \end{aligned} \quad (5)$$

$$U = 10 < U_{0.01;10;10} = 16 \quad (6)$$

- increasing the amount of polyunsaturated fatty acids (by 26.41%)

$$\begin{aligned} U_1 &= 10*10 + \left(10*(10+1)/2\right) - 149 = 6 \\ U_2 &= 10*10 + \left(10*(10+1)/2\right) - 61 = 94 \end{aligned} \quad (7)$$

$$U = 6 < U_{0.01;10;10} = 16 \quad (8)$$

Under the influence of rapeseed oil cake, the amount of especially favourable ω–3 fatty acids was increased by 11.28% and ω–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. ω–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 ω–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 ω–3 fatty acids by 11.28%, ω–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%.

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