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ECONOMIC FACTORS OF USING THE NEW PROTEIN CONCENTRATE IN RED DEER FEEDING

CZYNNIKI EKONOMICZNE ZWIĄZANE Z ZASTOSOWANIEM NOWEGO KONCENTRATU PROTEINOWEGO W ŻYWIENIU JELENIA SZLACHETNEGO

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Streszczenie. W celu zmniejszenia kosztów produkcji i podniesienia jakości produktu będącego rezultatem hodowli jelenia, na Łotwie podjęto eksperymenty z żywieniem jelenia szlachetnego z zastosowaniem koncentratów paszy, produktów ubocznych produkcji rolniczej, produkowanych w tym kraju. Oceniono ekonomiczną wydajność nowego koncentratu proteinowego (Baltiprot^{TM}-50) karmiąc jelenia szlachetnego (*Cervus elaphus*) odpowiednikiem o tej samej wartości energetycznej co przydział tradycyjnie stosowanej paszy zbożowej w okresie zimowym. W warunkach eksperymentalnych, wydajność produktu ubocznego powstającego w produkcji etanolu, stosowanego jako pasza dla jelenia szlachetnego w zimie została oszacowana przez dodanie 0.200 kg koncentratu proteinowego do codziennego przydziału paszy. W wyniku stosowania koncentratu białkowego zaobserwowano wzrost wydajności ekonomicznej paszy. W porównaniu do grupy kontrolnej, ilość i koszt paszy podanej jeleniom szlachetnym w grupie eksperymentalnej był mniejszy odpowiednio o 8.40% i 18.21%; ilość surowego białka przyswojonego przez organizm jeleni wzrosła o 5.00%, zaś koszt nieprzetworzonego i wydalonego surowego białka zmniejszył się o 30.95%; waga tuszy zwierzęcej wzrosła o 3.79 kg, a proporcje tkanki mięśniowej o 3.47%. Wzrost produktywności wynikający z obniżenia kosztów pozwala na bardziej wydajne korzystanie z aktywów gospodarstwa hodowlanego. Wyniki pozwalają na wyciągnięcie wniosku, że pasza z dodatkiem koncentratu białkowego Baltiprot^{TM}-50 wpływa znacząco na poziom wydatków i zyskowność hodowli jelenia. Wyniki ekonomiczne podawania miejscowej paszy z wysoką zawartością białka wskazują jednomyślnie, że takie pasze mogą być polecane gospodarstwom hodującym jelenie w celu zmniejszenia kosztów żywienia i zwiększenia produktywności.

Key words: deer farming, deer feeding, feed costs.
Słowa kluczowe: hodowla jeleni, koszty paszy, żywienie jeleni.

INTRODUCTION

Deer farming might be considered a prospective non-traditional agricultural industry having fast development possibilities. This is proved by an increase in the number of deer farms registered over the recent years. According to data of the Wild Animal Raising Association and the State Forest Service, 14 deer farms were registered in Latvia by the end of 2001, whereas on 31.12.2012 there were 61 such farms (Deer farms 2012).

Animal feeding efficiency and the provision of deer with the necessary nutritional energy to produce livestock products are two of the most important aspects in developing deer farming and are the basis for the production of quality products so as to ensure this industry's economic efficiency. Animal feeding problems have been extensively researched in

Latvia (Ramane 2001, Osītis 2004, Kairiša 2006, Trūpa 2006, Latvietis et al. 2008), yet, the accumulated experience over many years in feeding traditional livestock may only be being partially exploited in feeding deer raised in captivity, this is related to physiological differences between animals due to the way they are raised. Foreign research into deer farming (Fletcher 1989, Adam 1994, Loison et al. 1999, Tuckwell 2003, Sauve, Côté 2006) may not be often used for the particular conditions and development stage in deer farming in Latvia, as climatic conditions are different in various countries.

Latvian climatic conditions are suitable for raising red deer in a fenced territory all year round. Given the fact that deer live in fenced territories all year, their health condition and the productivity resulting from it are determined not only by the way these animals are fed and the conditions in which they are kept, but also by the surrounding environment – in autumn and winter periods, subject to the effect of climate, red deer may lose up to 20% of their body mass (Mitchell et al. 1977, Fletcher 1989, Loison et al. 1999, Tuckwell 2003, Sauve, Côté 2006). The body weight loss of red deer may be minimised by a balanced and high-protein feed.

Over recent years in many countries, studies into the sources of protein and protein levels in feed rations for ruminants have been done. A feed supplement with a high protein content is the most expensive component of feed rations.The fact that giving feed rations with a high level of protein might increase environmental pollution also has to be taken into consideration (Broderick, Clayton 1997, Shingfield et al. 2002). Food industry by-products, feeds with a high content of protein, are becoming more and more popular in feeding livestock. These are; various vegetable oil production by-products, rapeseed and soybean cakes, and by-products from ethanol production – Distillers Dried Grains with solubles (DDGS) etc.

By utilising various ethanol production technologies and using various raw materials of plant origin, ethanol production by-products of different protein content and quality are produced (Spiehs et al. 2002). According to Waldroup (2007), DDGS contain on average 26.5% crude protein and 0.73% total lysine.

It is economically efficient to produce ethanol from grain, and wheat is the best choice. By applying innovative solutions and technologies, ethanol production waste is reprocessed in Latvia into a feed supplement registered as Baltiprot^{TM}-50. On average, it consists of 55–60% crude protein, 1.28% lysine, 0.52% methionine, 1.71% arginine, and 94.5% dry matter. The concentrate of protein feed, contrary to the mentioned one in literature, is of better quality, as it contains relatively more crude protein and amino acids.

It enables enriching red deer feed rations with protein-rich feed supplements during the winter period, i.e. the protein concentrate Baltiprot^{TM}-50 may be used. There have been few studies on the economic and ecological efficiency of protein concentrates in red deer feed under Latvian conditions, there are, however, studies proving a successful use of the protein concentrate Baltiprot^{TM}-50 for chicken (Vītiņa et al. 2009, Vītiņa et al. 2010).

Feed with a high protein content is the most expensive component of a feed ration, therefore, it is important to assess its digestibility and assimilation in the animal's organism, which is significantly affected by the amino acids in the feed ration.

The digestibility and assimilation of crude protein, contained in feed, in the digestion system of animals are significantly characterised by the quantity of undigested and unassimilated crude protein in the manure excreted (Osītis 2005). Incomplete assimilation of feed, results in the productivity of animals decreasing and production costs per unit increasing, which affects economic efficiency indicators. At the same time environmental pollution may increase, undigested and excreted crude protein contains nitrogen and phosphorus, which are the main chemical pollutants arising from agricultural animals for the environment (Patterson 1998, Nahm, Carlson 2004).

Therefore, it is of great importance to study the digestibility and assimilation of crude protein contained in the protein concentrate Baltiprot^{TM}-50 in the organism of red deer. From the economic point of view, it is necessary to assess the cost of using the protein concentrate Baltiprot^{TM}-50 as a feed for red deer and to find out whether feed rations, supplemented with a premix rich in proteins, fed to the experimental group affected the productivity of these animals when compared to traditional feeds.

Therefore, the research aim was to assess the economic efficiency of the new protein concentrate Baltiprot^{TM}-50 fed to red deer during the winter period. The following research tasks were set: 1) estimate expenses of feed ration necessary for red deer; 2) identify expenses of crude protein utilised per feed ration; 3) compare the proportion of red deer carcasses in the control group and the trial group.

MATERIALS AND METHODS

Feed experiments were conducted on red deer (*Cervus elaphus*) raised on Latvian deer farms in fenced territories during the winter from December 2010 to April 2011. The snow depth was on average 47 cm (average snow depth was exceeded three times), the average temperature in months of winter (XII 2010 – II 2011) was −6.2ºC, the average temperature in February was –8.9ºC which was 4.1ºC below the annual average. (Description of Weather... 2011)

Before starting the experiment, two red deer groups of analogous age were established: a control group (n_1 = 10) and an experimental group (n_2 = 10). The control and experimental groups of red deer were fed with feeds of equal energy value (Table 1). According to studies of various authors (Fletcher 1989, Adam 1994), an animal of 150–200 kg has to consume on average 2.6–2.7 kg of dry matter, 320.0–330.0 g of protein, and 25.0–30.0 MJ of energy daily under winter conditions in accordance with the standard for seasonal physiological needs of red deer.

In the control group, on average 7.0 kg of silage and 1.100 kg of rolled oats were fed to each animal. For the experimental group, 0.200 kg of protein concentrate was included in their daily feed rations, replacing 0.880 kg of rolled oats (Table 1).

The experiment assesed the efficiency of feeding red deer the protein concentrate Baltiprot^{TM}-50 from economic aspects.

To identify the possible effect of feeding red deer the protein concentrate on the economic efficiency, costs associated with; daily consumption of feed per animal, the cost of feed consumed, and the quantity and costs of undigested and excreted crude protein were calculated.

The amount of manure excreted by the red deer made up on average 650 g (in dry matter), which was calculated according to the data provided by Latvian and foreign scientists (Tuckwell 2003, Timbare et. al. 2008). An undigested protein amount was determined by the methods: LVS EN ISO 5983-:2005 „Determination of nitrogen content and calculation of crude protein content – Part 1: Kjeldahl method (ISO 5983-1:2005)". Biochemical tests of feed and manure were done at the accredited biochemistry laboratory at the scientific institute Sigra of Latvia University of Agriculture in accordance with standard LVS EN ISOIIEC 17025-2005; all the tests were done in accordance with appropriate accredited ISO standards.

At the end of the experimental period, the proportions of muscle, bone, and adipose tissues were determined in the carcasses of the red deer from the control and experimental groups. Research data was analysed by a non–parametric method (Mann–Whitney U-criteria test) for data comparison (Arhipova, Bāliņa 2006). The Mann-Whitney U test is used to determine whether a difference exists between independent variables, deer of control group (n_1 = 10) and deer of trial group (n_2 = 10) (Formula 1).

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

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. Two independent variables – deer of control group (n_1 = 10) and deer of experimental group (n_2 = 10) – were compared at the significance level α = 0.01.

RESULTS AND DISCUSSION

Feeding red deer with the protein concentrate Baltiprot^{TM}-50 allowed a reducion in the amount of consumed feed. The cost of feed consumed also decreased for the experimental group compared to the control group (Table 1).

The daily consumption of feed amounted to 7.420 kg per red deer for the experimental group, which was. 0.680 kg or 8.40% less than for the control group. Thus, also decreasing the costs of consumed feed, the cost of feed per red deer was 18.21% lower for the experimental group than for the control group. The difference in feed costs was determined by differences in quantities and costs of crude protein for rolled oats and the protein concentrate. One kilogram of protein in rolled oats costs LVL 0.989, while in the protein concentrate – LVL 0.639. The run off of nitrogen and phosphorus from the utilised agricultural area (UAA) and livestock sheds causes a significant increase in environmental pollution. Most of the total amount of nitrogen and phosphorus (50–80%) getting into surface waters originate from anthropogenic, especially agricultural, sources of pollution (Skorupski 2012). In the aspect of food production, the environment is mostly polluted by meat production (Millston, Lang 2008, Global Challenges… 2009, Lauksaimniecības radītais piesārņojums 2011). Crude protein which is undigested by agricultural animals and then excreted from their organism is a chemical (nitrogen, phosphorus) and bacteriological (unfavourable microflora) source of pollution (Steinheider 1999, Nimmermark 2004, Łysko, Cyglicki 2004), the amount of which may be partially reduced by using feeds that have a higher rate of digestibility. A higher rate of digestibility, at the same time, provides higher economic return, i.e., higher productivity with lower or equal consumption of resources.

Table 1. Consumption and costs of feed and protein per deer per day

Parameters	Group 1 – control *(n = 10)*	Group 2 – trial *(n = 10)*	Deviation to control	
			bias	%
Feed ingredient:				
haylage, kg per day	7.00	7.00	0	0
rolled grain, (oats) kg per day	1.10	0.220	−0.880	−80.0
protein concentrate, kg per day	–	0.200	+0.200	+100.0
Total feed consumption, kg per day	8.10	7.420	−0.680	−8.40
Protein content:				
haylage, g	184.00	184.00	0	0
rolled grain (oats), g	141.00	28.35	−112.65	−80.0
protein concentrate, g	–	112.65	+112.65	+100.0
Total protein in feed, g	325.00	325.00	0	0
Feed costs:				
haylage, LVL per day	0.126	0.126	0	0
rolled grain (oats), LVL per day	0.154	0.031	−0.123	−79.87
protein concentrate, LVL per day	–	0.072	–	+100.0
Total feed costs, LVL per day	0.280	0.229	−0.051	−18.21
Costs of crude protein per 1 kg, LVL	0.862	0.705	−0.157	−18.21

Source: author's calculations.

The organism of a red deer in the experimental group assimilated 76.56% of crude protein available in feed during the winter period, being 4.33% more than was observed in the control group (Table 2). This data indicates that the digestibility and assimilation of crude protein was at a relatively higher level among the experimental group than the control group. The red deer among the experimental group excreted 15.58% less undigested crude

protein into the environment than those from the control group, i.e. the environmental pollution decreased.

Table 2. Quantity and cost of crude protein in the feed and manure of deer (per deer a day)

Parameters	Group 1 – control *(n = 10)*	Group 2 – experimental *(n = 10)*	Deviation to control	
			bias	%
Crude protein ingested from dry matter, g	325.00	325.00	–	–
Quantity of excreted manure per day, dry matter, g	650.00	650.00	–	–
Crude protein content in the excreted manure, g	90.24	76.18	−14.06	−15.58
Crude protein assimilated into the organism, g	234.76	248.82	+14.06	+5.99
Crude protein assimilated into the organism compared to that ingested, %	72.24	76.56	+4.33	–
Cost of ingested crude protein, LVL	0.28	0.229	−0.051	−18.21
Cost of excreted crude protein, LVL	0.08	0.05	−0.03	−30.95
Share of undigested crude protein in the total cost of feed, %	27.77	23.44	−4.33	–

Source: author's calculations.

As undigested crude protein is excreted and decomposes chemically and bacteriologically, it becomes a pollutant of the environment, yet it has to be emphasised that it also causes economic losses due to the incomplete assimilation of feed. In terms of money, the cost of undigested and excreted crude protein decreased by 30.95% compared to the control group (Table 2).

By feeding red deer the protein concentrate Baltiprot^{TM}-50, the total cost of feed consumed declined by 18.21% (Table 1), and the crude protein available in feed, including that in the protein concentrate, was used more efficiently. The cost of undigested and excreted crude protein was LVL 0.03 lower in the experimental group than in the control group, meaning the loss of crude protein available in feed decreased by 4.33% from the total feed cost. It means that by feeding the red deer the protein concentrate Baltiprot^{TM}-50, the economic efficiency of feed increased and, at the same time, environmental pollution decreased (Table 2).

The transformation of feed protein into the organism's protein is associated with the growth and regeneration of tissue and organs of a live organism, reaching a high concentration of protein in muscle tissue (Osītis 2005). It has to be emphasised that the amounts of amino acids available in feeds differ, thus affecting the growth of muscle tissue, which affects the productivity of animals. So, the economic efficiency of feeds used is specified by the productivity indicators of an animal. The quality of deer carcasses is basically determined by the ratio of muscle tissue, connective tissue, adipose tissue and bone tissue amount and nutritional value indexes.

According to data in literature, the meat of the highest quality is obtained from young stock deer usually slaughtered at the age of 14–16 months, their carcass weight at this age

amounts to approx. 60 kg (Vigh-Larsen 1987). The effect of feeding red deer the protein concentrate on their productivity was assessed in terms of proportions of muscle, adipose, and bone tissues in red deer carcasses. The proportions of these parts of carcase differed between the groups (Table 3). The age of slaughtered deer assessed in the trial ranged from 15–18 months and their carcass weight in control group ranged from 48.9 to 59.1 kg, an average was of 51.68 kg, carcass weight in trial group ranged from 49.6 to 63.6 kg, an average 55.46 kg.

Table 3. Average proportions and ratio of the components of red deer carcasses

Group	Carcass weight, kg ± SD	Muscle tissue		Adipose tissue		Bone tissue		Weight ratio of muscle to bone
		%	kg ± SD	%	kg ± SD	%	kg ± SD	
Group 1 – control (*n = 10*)	51.68 ±5.26	59.69	30.85 ±3.14	7.49	3.87 ±0.39	32.82	16.96 ±1.73	1.82
Group 2 – experimental (*n = 10*)	55.46 ±6.04	63.16	35.03 ±3.81	7.18	3.98 ±0.43	29.66	16.45 ±1.79	2.13
Deviation to control	3.78	3.47	4.18	–0.31	0.11	–3.16	–0.51	0.31

Source: author's calculations.

According to the experimental data (Table 3), over the trial period, supplementation of traditional red-deer feed with the protein concentrate increased the yield of meat by on the average by 7.31% (3.79 kg) per deer in comparison with the control group. By feeding the red deer the feed containing the protein concentrate Baltiprot^{TM}-50, the carcass of red deer had higher proportions of muscle tissues, 3.47% respectively, while the proportion of bone tissue was 3.15% lower compared to the control group. By performing a Mann-Whitney U-criteria test (Formula 2), it was found that the proportion of muscle tissue (Table 3) was significantly greater for the experimental group.

$$U_{\alpha(1)};\ n_1;\ n_2 = U_{0.01;10;10} = 16 > U = 6 \quad (2)$$

Therefore, the weight ratio of muscle to fat was higher for the experimental group (2.13), it was, in absolute terms, 0.31 higher than for the control group. It means that the use of the protein concentrate Baltiprot^{TM}-50 in feed rations for the red deer promoted their productivity and increased the share of carcase useful for food, i.e. the proportions of muscle and adipose tissues in their carcasses (Table 3).

CONCLUSIONS

The economic efficiency of feeding the protein concentrate Baltiprot^{TM}-50 to farmed red deer (*Cervus elaphus*) over the winter season was assessed under trial conditions, by adding 0.200 kg of protein concentrate to their daily feed ration. If compared to the control group of red deer:

1) the amount and cost of consumed feed decreased by 8.40% and 18.21%, respectively;

2) the quantity of crude protein assimilated into the organism increased 5.99%;

3) daily environmental pollution from undigested crude protein, contained in manure, decreased by 15.58%, while the cost of undigested and excreted crude protein decreased by 30.95%;

4) the carcass weight of red deer increased by 3.79 kg on average and the share of carcass suitable for food, the proportion of muscle tissue, rose by 3.47%.

An increase in productivity due to a reduction in the cost level indicates a rise in the efficiency of the use of farm assets. It enables us to conclude that feeding protein concentrate Baltiprot^{TM}-50 to deer significantly affects the expenditure and profitability of a deer farm. The economic results of feeding local feeds with high protein content convincingly showed that these feeds may be recommended for deer farms to reduce their feed cost and raise their productivity.

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