UDC 599.735.31/636.084.55 http://dx.doi.org/10.15407/animbiol18.04.022

CHEMICAL COMPOSITION AND NUTRITIONAL VALUES OF FEED RESOURCES FOR DEER

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Increasing of wild animals populations and saving of endangered species require proper providing of nutrient needs. In general, the available feed resources provide the feed needs of wild herbivores, but the ratio of the individual components of the diet often requires additional balancing. Therefore, the nutrient requirements for wildlife are not fully studied.

The aim of our research was to establish the chemical composition and nutritional values of natural and supplemental feeds for deer in the Kivertsi State Forestry Enterprise (Volyn' Region, Ukraine). A study of the nutritional value of hay, grass and leaves harvested at the forestry enterprise territory has been elaborated. Samples have been collected from oak and hornbeam mixed forest, birch grove and meadow (forest glade). Samples of grasses were taken from five sites (0.5 m^2) located at each area. Samples of leaves twigs were collected from five trees of each species. Samples of hay were taken from five stacks. Additionally, we investigated the composition of some supplemental feeds: wheat and corn grains and soybean meal.

In general, investigated feeds satisfy nutritional requirements of deer, but contents of some components require additional correction. Particularly, available on the territory fodder are deficiencies in phosphorus, copper and zinc, so replenish of mineral additives are necessary. Deer requires more manganese than other animals need. Investigated feeds contain not sufficient amount of manganese to ensure the needs of deer. Available in the investigated areas natural feed are providing the protein requirement of adult animals. However, for the fawns, lactating hinds and stags during antlers growth the content of protein in the diet may be insufficient.

Keywords: DEER, NUTRIENT REQUIREMENTS, NATURAL FEEDS COMPOSITION, SUPPLEMENTAL FEEDING

ХІМІЧНИЙ СКЛАД І ПОЖИВНІСТЬ КОРМОВИХ РЕСУРСІВ ДЛЯ ОЛЕНІВ

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Для збереження зникаючих видів і збільшення популяції диких тварин необхідне належне забезпечення їх потреб у поживних речовинах. Загалом кормові потреби диких травоїдних забезпечуються наявними кормовими ресурсами, проте співвідношення окремих компонентів дієти часто потребує додаткового балансування. Крім того, не в повній мірі встановлені вимоги в поживних речовинах для диких тварин.

Метою досліджень було встановлення хімічного складу та поживності природних кормів і компонентів підгодівлі для оленів на території Державного підприємства «Ківерцівське лісове господарство»

(Волинська область). Зразки трави, листя та пагонів дерев відбирали на трьох рослинних угрупуваннях: дубово-грабовий мішаний ліс, березовий гай та луки. Досліджувані трав'яні рослини: осока пухнастоплода (Carex lasiocarpa), осока гостровидна (Carex acutiformis), осока видовжена (Carex elongata), костриця червона (Festuca rubra), мітлиця повзуча (Agrostis stolonifera), мітлиця собача (Agrostis canina), щучник дернистий (Deschampsia caespitosa). Листя та пагони брали з берези пониклої (Betula pendula), граба звичайного (Carpinus betulus), дуба черешчатого (Quecus robur), осики (Populus tremula) та крушини ламкої (Frangula alnus). Зразки трав брали з п'яти ділянок площею 0,5 м^2 кожного угрупування. Листя та пагони брали з п'яти дерев кожного виду. Зразки сіна відбирали з п'яти копиць. Крім того, досліджували корми, що використовувались для підгодівлі тварин: зерно пшениці та кукурудзи та соєвий шрот.

Загалом досліджувані природні корми забезпечують основні потреби оленів у поживних та біологічно активних речовинах, проте вміст деяких компонентів потребує коригування з урахуванням вікових особливостей та фізіологічного статусу тварин. Зокрема, виявлено дефіцит Фосфору, Купруму та Цинку, що необхідно враховувати при здійсненні підгодівлі. Вміст Мангану у цілому достатній, проте олені потребують більшу, ніж інші тварини, кількість цього мікроелементу, тому для них доцільне додаткове введення Мангану до складу мінеральних добавок. Наявні на досліджуваній території природні корми забезпечують мінімальну потребу дорослих тварин у протеїні. Для молодняку, лактуючих самок та самців оленів у період росту рогів вміст протеїну в кормах недостатній, бажана підгодівля високобілковими концентрованими кормами.

Ключові слова: ОЛЕНІ, ПОТРЕБА У ПОЖИВНИХ РЕЧОВИНАХ, СКЛАД ПРИРОДНИХ КОРМІВ, ПІДГОДІВЛЯ

ХИМИЧЕСКИЙ СОСТАВ И ПИТАТЕЛЬНОСТЬ КОРМОВЫХ РЕСУРСОВ ДЛЯ ОЛЕНЕЙ

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Для сохранения исчезающих видов и увеличения популяции диких животных необходимо надлежащее обеспечение их потребностей в питательных веществах. В целом, кормовые потребности диких травоядных обеспечиваются имеющимися кормовыми ресурсами, однако соотношение отдельных компонентов диеты часто требует дополнительного балансирования. Кроме того, не в полной мере установлена потребность в питательных веществах для диких животных.

Целью исследований было установление химического состава и питательности природных кормов и компонентов подкормки для оленей на территории Государственного предприятия «Киверцовское лесное хозяйство» (Волынская область). Образцы травы, листьев и побегов деревьев отбирали на трех растительных группировках: дубово-грабовый смешанный лес, березовая роща и луг. Исследуемые травяные растения: осока волосистоплодная (Carex lasiocarpa), осока островидная (Carex acutiformis), осока удлиненная (Carex elongata), овсяница красная (Festuca rubra), полевица ползучая (Agrostis stolonifera), полевица собачья (Agrostis canina), луговик дернистый (Deschampsia caespitosa). Листья и побеги отбирали с берёзы повислой (Betula pendula), граба обыкновенного (Carpinus betulus), дуба черешчатого (Quecus robur), осины (Populus tremula) и крушины ломкой (Frangula alnus). Образцы трав брали из пяти участков площадью 0,5 м^2 каждой группировки. Листья и побеги брали из пяти деревьев каждого вида. Образцы сена отбирали из пяти стогов. Кроме того, исследовали корма, используемые для подкормки животных: зерно пшеницы и кукурузы и соевый шрот.

В общем, исследуемые природные корма обеспечивают основные потребности оленей в питательных и биологически активных веществах, однако содержание некоторых компонентов требует корректировки с учетом возрастных особенностей и физиологического статуса животных. В частности, обнаружен дефицит фосфора, меди и цинка, что необходимо учитывать при осуществлении подкормки. Содержание марганца в целом достаточно, однако олени требуют большее, чем другие животные,

количество этого микроэлемента, поэтому для них целесообразно дополнительное введение марганца в состав минеральных добавок. Имеющиеся на исследуемой территории природные корма удовлетворяют минимальную потребность взрослых животных в протеине. Для молодняка, лактирующих самок и самцов оленей в период роста рогов содержание протеина в кормах недостаточное, желательна подкормка высокобелковыми концентрированными кормами.

Ключевые слова: ОЛЕНИ, ПОТРЕБНОСТЬ В ПИТАТЕЛЬНЫХ ВЕЩЕСТВАХ, СОСТАВ ЕСТЕСТВЕННЫХ КОРМОВ, ПОДКОРМКА

Maintaining optimal living conditions for animals depends on balance of nutrients and bioactive substances in the diet and on adequate feed quality. Additionally, estimating the feeding value of ruminant diet, features of their anatomy and physiology should be taking into account [9, 17, 19, 27, 40]. Ruminants have a specific digestive system that allows using nutrients more effectively compared to other herbivores. Owning to microbial fermentation in rumen, they able to assimilate nondigestible for monogastric animals components of plants. Due to such peculiarities of digestion, ruminants can consume a feed with high content of fiber (cellulose and hemicelluloses) which after rumen fermentation provides animal body with volatile fatty acids necessary as metabolic energy supplier and for biosynthesis of animal cell components. Subsequently, rumen microorganisms are digested in the intestine causing the animal receive additional amount of essential amino acids, B-group vitamins and vitamin K [28–30].

Despite the importance of monitoring the intake of main nutrients by wild animals this aspect has been investigated not enough. To optimize the wild animals feeding usually apply the theoretical knowledge of nutritional requirements for domestic animals which established considerably better [28–30], although the norms for deer existing too [30]. However, the balancing of wild and farm animal diets has different goals, what is necessary to take into account when assessing the quality of diets. The nutritional norms for farm animals feeding focused on obtaining maximum performance parameters, while for wildlife, the main aim is maintaining appropriate health status, and consequently this is reflected in the size of the population. Thus, farm animal nutrition intended to maximize the performance and reduce the cost of production for more profitability; the purpose of wild animals feeding is to preserve species existence. Unbalanced diet of wild animals does not directly threaten their life but the control of diet composition improves the physiological and health states, increases resistance to adverse conditions of existence and stimulates reproductive function. Therefore, for maintenance of wildlife population size the level of adequacy providing with essential nutrients need be monitored in the complex with other environmental measures.

According to feed priorities, the ruminant animals may be divided into 3 groups: roughage consumers (grazers), consumers of feed from trees and bushes (browsers) and intermediate type. These types have some differences in structure and functions of the digestive system that must be considered in evaluating of provision animal with nutrients [10, 15, 16, 25, 41]. The total length of the intestines in grazers are 25–30 times exceeds the length of the body, and the colon occupies only 18–20 %; whereas in browsers, size of intestines is only 12–25 times larger than the length of the body, and length of the colon is 27–35 % of the total length of the intestines [37]. Browsers saliva contains tannin-binding proteins [1] that makes possible to consume the leaves of trees and shrubs. Liver of browsers is twice bigger than liver of grazers what allowing better neutralize harmful components of feed [10, 16]. Deer belong to ruminants with intermediate (red deer, sika deer, fallow deer) or browse (elk, roe deer) type of digestion [4, 15, 16, 25, 41].

Nutrient requirements of deer depend on age, sex, physiological status, and season. The lowest feed intake observed in winter caused by metabolic alteration influenced by hormonal changes. These changes are regulated by epiphyseal hormone melatonin the formation of which depends on the duration of daylight [6].

During winter deer consume feed (on a dry basis) for 1.5 % of body weight, in the summer feed intake increases to 3.0 %. With additional grain and legume supplementation deer daily need

on average about 2.3 kg of dry matter with 10–20 % of crude protein and 20–30 MJ of metabolizable energy [42]. Increase the concentration of protein in the dry matter from 8.0–10.0 to 16.0 % increases antlers size twice [11]. If the protein in the diet is less than 5 % antlers growth stops. Deer diet (on DM) should contain 0.40 % calcium and 0.30 % phosphorus, during lactation and growth of horns requirement increases to 0.75 and 0.45 %, young animals need 0.6 % calcium and 0.4 % phosphorus [33, 41].

Forage for wild ruminants consist a broad spectrum of plants that are available in the forests, glades and meadows, including grass, leaves, twigs, bark, acorns and other components of the forest floor. It is believed that for deer with intermediate type of nutrition (red deer, sika deer, fallow deer) the roughage intake in an amount up to 20 % of the dry matter are sufficiently. The maximum quantity of roughage that these deer can digest is 80 % [18, 26].

In the wild, deer mainly feed on trees and bushes (leaves, stems, fruits, acorns, bark), which account for 50–80 % of the diet. Part of herbaceous forage (grass, sedges, and grasses) in the diet of deer approximately makes 15–30 % [7, 23, 35]. In addition, deer eat shrubs, mushrooms, ferns, club mosses, horsetails, mosses, lichens [4, 8, 16, 25, 30, 31] and, in particular cases, aquatic plants [3]. Among trees deer willingly choose oak, pine, spruce, willow, hornbeam, sorbus, aspen, maple, alder, birch; bushes: raspberries, hazel, buckthorn, juniper, berberis, crataegus, viburnum, daphne, sambucus; shrubs: vaccinium, calluna, mistletoe; fungi: honey fungus, also eat russule, lactarius, brown roll-rim, garlic parachute, amanita [5, 7, 23, 35].

For the farm deer, feeding can be organized in three ways: pasture maintenance; feeding with composition of roughages and concentrated feeds; feeding of complete feed mixtures [26]. It is necessary to pay attention to the physiological characteristics of digestion of deer, proper selection of feed additives, minerals and vitamins components, feed quality control [20, 21, 32, 36]. However, for additional feeding of wild deer mainly take into account the average requirement of herd. The recommended levels of supplementary feeds (grain, beans) for large species (red deer) are about 1 kg and for small species (roe deer) — 0.5 kg for animal per day. If deer are kept on the farm, the composition and nutritional value of the diet are set to achieve maximum productive performance and economic efficiency taking into account age, gender and physiological condition of individual animals [18, 39].

Materials and Methods

The structure of investigated area is generally favorable for herbivores. The predominant type of lands is deciduous and coniferous forest. Regarding the quality of areas and forest stand area meets the biological characteristics of ruminant species, their habitat requirements. Water supply is sufficient. Weather conditions are favorable for the existence characterized by moderate continental with mild winters and warm, not hot summer. Winters with substantial snow cover and frost are rare. Sod-podzolic soils on fluvioglacial deposits are prevailed. The forest vegetation dominated, swamps and grasslands account for about 1 %, ponds occupy even less space. In the forest pine, oak, alder, birch and aspen are prevalent. There are some areas of spruce (*Picea abies*) in the forest. Age of the forest plantations is about 70-year-old, trees density ranged from 0.60 to 0.82. Shrub layer is represented mainly by thickets of breaking buckthorn (*Frangula alnus*) in wetter areas and hazel (*Corylus avellana*) in drier areas. The density of shrubs is typically within 0.2–0.4 [20]. The density of animal population on 1,000 hectares of lands: for bison — 0.5–0.8, red deer — 5–6, sika deer — 6–14, roe deer — 13–15, elk — 0.2 [38].

The grasses, leaves and twigs have been randomly collected in July-August 2015 on the territory of Kivertsi State Forestry Enterprise (50º51′ N, 25º36′ E). Glade grass was characterized by diverse species composition included: slender sedge (*Carex lasiocarpa*), lesser pond sedge (*Carex acutiformis*), elongated sedge (*Carex elongata*), red fescue (*Festuca rubra*), buffalo grass (*Anthoxanthum odoratum*), creeping bent (*Agrostis stolonifera*), brown bent (*Agrostis canina*), tufted hairgrass (*Deschampsia caespitosa*). Leaves and twigs were taken from silver birch (*Betula pendula*), european hornbeam (*Carpinus betulus*), pedunculate oak (*Quecus robur*), european aspen (*Populus tremula*) and breaking buckthorn (*Frangula alnus*).

Samples of grasses were taken from five sites (0.5 m^2) located at each area. Samples of hay were taken from five stacks. Samples of leaves and twigs collected from five trees of each species.

Samples were oven-dried at 65 °C for 48 h and then at 105 °C to achieve a stable mass. Dried materials were ground and weighed in an amount of 1.0 g for investigation of protein, fat and fiber and 10.0 g for estimation of mineral composition.

Crude protein (CP) was analized by the macro-Kjeldahl technique, neutral detergent fiber (NDF) and acid detergent fiber (ADF) according to Goering and Van Soest. Total fat was determined by Soxhlet method. Ca, Na, K, Fe, Cu, Zn, Mn, Co, Cd, Pb were analyzed by atomic absorption spectrophotometry. For analisis of mineral composition the studied material was dry-ashed in a muffle furnace at 450 °C for 10 h, by a temperature rising rate of 50 °C per each 30 min. Phosphorus (P) content was estimated photometrically using a molybdovanadate reagent.

Results and discussion

No substantial differences of basic nutrients concentrations in the hay and grass have been found, although some peculiarities of their chemical composition were detected. Particularly, hay contains slightly less crude protein and fat than grass, what may be due to various reasons: different plant species composition, origin from other areas or losses during harvesting.

For deer in certain physiological condition protein deficiency can be observed, so maybe is advisable an addition of protein supplements. For maintenance of body weight and to support of normal activity, diet of mature deer must contain at least 6–8 % of crude protein per 1 kg of dry matter, but for full realization of vital functions feed intake should be 11–22 % what depends on the season, age, sex and physiological status. Adult female deer at late pregnancy needs diet with 11–15 % of crude protein, during lactation the requirement increases to 14–22 %. Deer male diet during antler grows must include 15–16 % of crude protein [12–14, 34, 41]. Fawn males need more concentration of protein (16–18 %) than female fawns (14–16 %) [33]. To maximize fawns growth, protein concentration in the diet should be 20 % [34]. Thus, in certain physiological conditions, deer diet could contain an insufficient protein concentration.

Substantial differences in the mineral composition of the investigated feeds have been found. Dry matter of leaves contained considerably less amounts of phosphorus, magnesium, potassium, iron and cobalt. Despite the differences in magnesium content, amount meets the need of deer. Content of potassium in hay and grass exceeds the required for animals level.

Excess potassium can be compensated by supplementation of diets with sodium what carried in the Kivertsi State Forestry Enterprise using licks salt blocks. The iron and cobalt content is also somewhat exceeds the norm, what is typical for Ukraine. However, deer need more iron and cobalt than other ruminants so for them these quantities are quite adequate. Cobalt is essential for ruminant as precursor of vitamin B_{12} synthesis by ruminal bacteria. Cobalt may also be beneficial in ruminant diets as a means of improving the efficiency of fiber digestion [40]. Examined feeds contain insufficient amounts of copper and zinc, because deer need more Cu and Zn, especially during the growth of antlers. Deer requires more manganese than other animals need. This is due to the necessity of this mineral for antler growth. The role of manganese in the formation of antlers not yet fully established, but positive effects of manganese suplementation for adult male deer have been pointed [2, 22, 32]. Investigated feeds contain not sufficient amount of manganese to ensure the needs of deer.

Optimal ratio of calcium to phosphorus in deer diet must be about 1.5:1, whereas in roughages this value ranging from 3:1 to 5:1. In our case, calcium-phosphorus ratio is 3:1 that indicates the necessity of phosphorus dietary supplements. This imbalance can be leveled by addition of grain, ratio of calcium to phosphorus in which varies within 1:3–1:10 or by supplementation of diet with mineral additives.

When ruminants are fed with grain the peculiarities of its digestion should be taken into account. Firstly, they hardly digest whole grains because do not chews seeds, so grain need be crushed. This creates additional difficulties associated with costs for the preparation and storage. Moreover, milled grain is perishable what can

Table

Chemical composition of feeds and nutrient requirements (on DM basis)

Nutrients	Forages				Supplements			Requirements [30, 33]	
	Hay	Grass	Leaves	Twigs	Wheat grain	Corn grain	Soybean meal	Deer	Sheep, goats
DM, %	83.55	32.13	26.33	18.28	84.52	86.31	91.80	–	–
CP, %	10.03	13.97	30.45	20.03	11.91	10.52	44.34	10-20	10-20
Fat, %	3.27	4.03	2.41	1.65	2.24	4.21	2.51	n/a	n/a
CF, %	31.92	33.90	13.76	18.92	2.43	4.08	6.12	n/a	n/a
NDF, %	63.74	59.99	30.42	36.42	8.91	16.54	15.23	n/a	30–45
ADF, %	35.24	32.09	12.39	23.08	3.58	5.16	10.37	n/a	n/a
Ca, %	0.62	0.60	0.49	0.76	0.09	0.05	0.31	0.4–0.7	0.2–0.8
P, %	0.23	0.19	0.23	0.13	0.41	0.25	0.83	0.3–0.5	0.2–0.4
Mg, %	0.19	0.21	0.25	0.09	0.12	0.16	0.45	0.2–0.3	0.1–0.2
K, %	1.28	1.66	0.85	0.27	0.36	0.35	2.22	0.6–0.7	05–0.8
Fe, ppm	170.05	239.30	124.34	111.21	37.26	51.37	238.30	200–300	30–50
Cu, ppm	4.88	3.90	4.71	3.12	4.59	4.95	15.13	15–20	7–11
Zn, ppm	12.14	11.95	14.22	10.80	28.45	21.58	38.72	75–100	20–33
Mn, ppm	49.18	80.70	78.20	63.15	24.36	6.72	42.14	100–110	20–40
Co, ppm	0.40	0.40	0.23	0.27	0.11	0.15	0.09	0.2–0.3	0.1–0.2
Cd, ppm	0.34	0.32	0.26	0.21	0.14	0.11	0.15	<0.3	<0.3
Pb, ppm	2.35	2.38	2.49	2.08	1.28	1.39	1.92	<3.0	<3.0

Note: for Cd and Pb — threshold limit values (maximum permissible limits)

cause indigestion and even poisoning. Secondly, the composition of the diet of ruminants should be changed gradually to prevent digestive disorders, because rumen microorganisms must be adapted to new substrates during 2–3 weeks by altering of species composition and enzymes activities [40]. So adding to and removing from diet of concentrates must be gradually and after adaptation grain should be fed constantly in approximately equal quantity. We found a deficit of phosphorus while the calcium content is sufficient. However, available feed additives for wild herbivores contain calcium, so even in the presence of mineral supplements imbalance of calcium to phosphorus ratio remains. Maybe, the best option for replenishment lack of protein and phosphorus in the diet is the addition to the diet meals of oil-seeds crops, which contains a large amount of protein and ratio of calcium to phosphorus is close to what is in the grain.

Conclusion

In general, investigated feeds satisfy nutritional requirements of wildlife ruminants, but contents of some components require additional correction. Particularly, available on the territory fodder are deficiencies in phosphorus, copper and zinc, so replenish of mineral additives are necessary. Deer requires more manganese than other animals need. Investigated feeds contain not sufficient amount of manganese to ensure the needs of deer. Available in the investigated areas natural feed are providing the protein requirement of adult animals. However, for the fawns, lactating hinds and stags during antlers growth the content of protein in the diet may be insufficient.

Prospects of further researches. It is necessary to develop recipes of feed additives for each region, taking into account the composition and nutritional value of local natural feeds.

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