

Sunflower in the Diet of Siberian Roe Deer (*Capreolus Pygargus*) During the Winter High-Snow Period: Clinical and Morphological Criteria of the Digestive System



V.B. Yermolik, Yu.D. Schmidt, P.N. Smirnov

Abstract: *The article presents innovative environmental methods as a basis for biotechnological approaches of sunflower cultivation to be used for supplementary feeding of roe deer in their natural habitat in the winter, in order to preserve the animal population and to maintain the biological balance of the ecosystem at the Kirzinsky Federal State Natural Reserve in the Novosibirsk region. The article provides the basic pathoanatomical and morphological criteria of the metabolic processes in the organism of Siberian roe deer in case of using sunflower in their diet. A high level of anabolic (cumulative) processes in the roe deer organism is identified, which is manifested in the formation of large fat depots, thus reflecting the high degree of stability of the biological system to the occurrence of natural extraordinary factors in the natural habitat of the roe deer. The examination has shown that the rumen is satisfactorily filled with homogeneous contents of moderate humidity. Forage mainly consists of sunflower represented by the sunflower groats with grains (seeds) of various degree of mechanical and biological crushing. The use of sunflower as supplementary feed in extensive fodder fields allows Siberian roe deer to accumulate energy reserve in the winter with significantly high snow cover, for ensuring the forming and metabolic processes, especially in the extreme conditions of living in the wild.*

Keywords: *Siberian roe deer (*Capreolus pygargus*), highsnow, sunflower, biotechnology, pathoanatomical examination, metabolism.*

I. INTRODUCTION

In Western Siberia, Siberian roe deer is the most representative species of wild cloven-hoofed animals. Preservation and reproduction of the roe deer as a hunting resource depends on the quality and the year-round availability of feed. In the winter, the high snow level imposes a natural limitation on the feed availability for the wintering population of the Siberian roe deer. For survival, they are forced to feed mostly on browse, which has low

nutritional value and cannot fully ensure the energy balance of the roe deer.

Feed support initiatives for ensuring survival of Siberian roe deer in the hard wintertime, involves biotechnical activities aimed at improving the availability and quality of winter feeds of the wild ungulates. The existing method and practice of using biotechnology in the extreme conditions of the Siberian winter do not allow a full protection of the wild animals from exhaustion, which results in reduced reproductive potential of the populations, and often leads to massive death of the roe deer.

At the Kirzinsky Federal State Nature Reserve in the Novosibirsk region, which plays a key role in preservation and multiplication of the fauna of the Western Siberia, the behavior of the roe deer in the extreme conditions of the winter high snow has been scientifically monitored for several years.

The studies were aimed at development and use of new biotechnological technologies that contributed to the formation of the affordable and adequate winter forage base for Siberian roe deer. In line with this, methods and principles of providing feed for the wintering population of wild ungulates have been developed, which gradually transformed into biotechnological experiments with sustainable long-term positive results.

Large feeding areas were created in the natural reserve for supplying feed for the roe deer in the winter, where tall plants such as sunflower (*Helianthus*) were sown.

A bioengineering program of Siberian roe deer preservation in the conditions of winter high snow was developed, which was based on creating large forage fields of 30 – 50 ha with the total area of 900 ha on the territory of the Kirzinsky Federal Natural Reserve, which was part of the Sayano-Shushensky Natural Biosphere Reserve (Figure 1).

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Fig. 1: A bioengineering field with sunflower

Sunflower (*Helianthus*) belongs to the Asteraceae family. Sunflower seeds are rich in magnesium; they contain proteins, fats, amino acids, vitamins D, E, and C, carotene, and B-group vitamins. It is an energy-valuable crop. The energy balance for proteins is 14 %, for fats — 79 %, and for carbohydrates — 7 %.

Out of the diverse range of cultivated sunflower species, the Yenisei cultivar was chosen for the bioengineering program at the Natural Reserve. This cultivar has universal oilseed and forage properties, and was bred at the Krasnoyarsk Research Institute of Agriculture. It is an ultra-early ripening cultivar of sunflower; the duration of the vegetation period from full germination to full economic maturity is 78-100 days, which 10-12 days earlier than the standard cultivars. Sunflower is sown in the first half of June to provide sufficient period for complete ripening of the crop. The crop is left standing to be used as a feed resource for the wild ungulates in the wintering cycle.

The sunflower stem is erect, ligneous, unbranched, covered with stiff sparse hairs. The plant height is 120 cm and more, which is a valuable parameter for biotechnical intervention of this crop. Increasing the plant height will ensure that its top fodder part in the form of a head with the seeds remains above the snow cover, thus remaining accessible for winter feeding of Siberian roe deer.

The average diameter of the sunflower head in case of compacted seeding is 10-16 cm, which is the most convenient size for wild animals. Sunflower ripens evenly; and the crop is resistant to lodging, shattering and frost, which are important biotechnical quality of this feed crop. It also features high resistance to sunflower moth, Broomrape, Botrytis and Sclerotinia disease. This cultivar is characterized by a high level of drought resistance. It has remained in the State Grade Testing and Zoning since 1961. Since 1971, it has been widespread in the Altai and Krasnoyarsk territories, in the Omsk, the Orenburg, the Kurgan, the Novosibirsk, and other regions. It has been introduced into the State Register of Breeding Achievements of the Russian Federation.

Leaving sunflower standing for the winter nutrition of Siberian roe deer, will provide sufficient amount of dry substance, along with protein and polyunsaturated fatty acids rich seeds. Polyunsaturated fatty acids have a beneficial effect on the entire process of digestion in the roe deer.

This study evaluated the dynamics of the metabolic processes in the Siberian roe deer in response to the supplementary feeding of sunflower crop during winter.

The purpose of the study was to substantiate, based on the

clinical and morphological studies of the digestive system of Siberian roe deer, the feasibility of using sunflower (*Helianthus*) for mass supplementary feeding of Siberian roe deer during winter high snow period.

The following tasks were set:

1. Capturing three roe deer for scientific purposes in the territory of the sunflower fields of the National Reserve.
2. Performing autopsy of the roe deer by an expert committee at the Faculty of Veterinary Medicine of NSAU, with video recording and logging of the research procedures.
3. Performing a pathoanatomical examination in the following order: digestive – cardiovascular – urinary – respiratory systems, liver, lymphatic nodes, glands of internal secretion.
4. Selecting material for the histological study of the forestomach, the intestines, the kidneys, the liver, etc.
5. According to the results of the comprehensive study, to give an opinion about the appropriateness of using sunflower for supplementary feeding of the roe deer in the winter.

II. MATERIALS AND METHODS

The subjects of the study were internal organs of the roe deer captured at the Kirzinsky Federal Natural Reserve between November 20 and December 05, 2016.

To achieve this goal, the method of complex pathoanatomical examination of internal organs of the roe deer with detailed description and morphometry of the discovered changes was used.

III. RESULTS

Macroscopic examination of the internal organs revealed correct placement of organs in the abdominal cavity (the forestomachs, the thin and thick intestines); moderately developed digestive glands (the liver and the pancreas); the mesentery and the omenta had considerable fat deposits, which was evidence of expressed processes of anabolism and accumulation of reserve energy substances in case of using sunflower for the winter feeding diet (Figure 2).



Fig. 2: Roe deer organs in the abdominal cavity

Opening of the rumen showed its satisfactory filling — the content was homogeneous, moderately wet, the forage mass mainly consisted of sunflower in the form of sunflower groats

with sunflower seeds in varying degrees of mechanical and biological of crushing (Fig. 3, 4).



Fig. 3: Rumen



Fig. 4: Rumen content

Opening of the forestomach, the omasum, and the rennet showed moderate filling of the sections, good development of the walls of the forestomach and the mucous membrane; the content was homogeneous, loose in the omasum, and fluid in the rennet (Fig. 5, 6).



Fig. 5: Omasum



Fig. 6: Rennet with fluid feed mass

The morphological assessment of the forestomach showed well-developed structures, which ensured both the digestive processes at the level of the biochemical processes, and the motility of the forestomach in general. For instance, well-developed mucous coat was found in the rumen; its villous layer was structured and showed the high level of the functional status of the forestomach section (Fig. 7).



Fig. 7: The mucous coat of the rumen

Assessment of the liver by macroscopic characteristics showed a steady rate of metabolism, and a moderately developed structure of the digestive gland (Fig. 8).



Fig. 8: Liver

The morphological assessment of the kidneys showed the existence of an abundant adipose capsule; the renal parenchyma was satisfactorily developed, a clear separation into histological sections (cortical and medullary layers) was visible, the renal pelvis was well-developed (Fig. 9, 10).



Fig. 9: Kidney



Fig. 10: Kidney cross-section

The morphological assessment of the cardio-respiratory system showed the physiologically full development of the lungs and the heart. The lungs were moderately filled with the blood, the lobed structure was clearly visible, the trachea and major bronchi remained without any visible changes (Fig. 11).



Fig. 11: Lungs

By the main morphological criteria, the heart showed high functional activity during the lifetime, the heart compartments were developed in accordance with the anatomic and topographic norms, the endocardium and the valvular heart apparatus did not have any changes like overlays, or congenital anomalies of development (Fig. 12, 13).

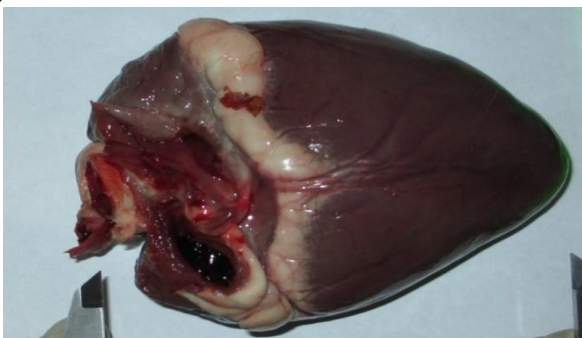


Fig. 12: Heart

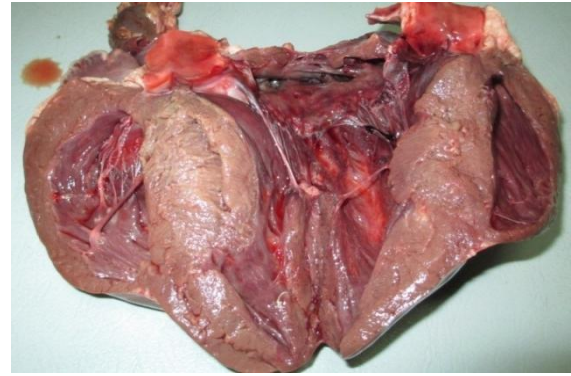


Fig. 13: Heart cross-section

IV. DISCUSSION

Manteifel [1] laid the bases for the science of breeding wild hunting animals and birds in natural conditions.

According to Lvov [2], by the intended purpose, biotechnology should be divided into the hunting (and fishing) and the survival biotechnology. The author further remarked: "As for hunting, its purpose is providing trophies, breeding and other shootings. The purpose of the survival biotechnology is the preservation of the reproductive core of populations in critical periods of their existence." Further focus will be put exactly on this part of the biotechnology, since maintaining the population, and even more so, expanded reproduction of the species, is impossible without active implementation of the bioengineering technologies at Natural Reserves.

According to Grosheva [3], "Preservation of biological and landscape diversity is one of the most pressing geo-ecological issues."

According to the modern classification, biological activities are divided into two main groups – general constructive measures, and individual, mostly restrictive measures. The first group includes bioengineering works aimed at restoring the hunting grounds within a certain period for ensuring the feed for commercial animals — this includes biotechnological reconstruction of the forest stands, forage and protective crops, planting of perennial crops, creating artificial water bodies, etc. [4-8].

The biotechnological tools traditionally used in Russia, including procurement of browse, hay, dried brooms, organization of feeding grounds, are inefficient, and do not always attain the desired effect. This is especially evident in snowy winters [9-12].

Therefore, the current biotechnology does not include the methods that can keep large groups of ungulates from forced migration in the winter and ensure efficient protection of the roe deer population from jacklighters. A detailed analysis of the effect of the winter environmental factors on wild ungulates was the subject of numerous publications of A. P. Semenov Tyan-Shansky [13-15], P. B. Jurgenson [16-17], A. A. Nasimovich [18-20], A. N. Formozov [21-23], P. F. Kaznevsky [24], S. V. Kirikov [25, 26], A. D. Vladyshevsky [27], V. E. Sokolov, A. A. Danilkin [28], A. A. Danilkin, V. A. Ostanin, V. A. Strekalovskikh [29,30], A. I. Maltsev [31, 32].

The modern system approach, the complex resolution of the problems of

interaction between the man and wild animals determined the development of another, broader thinking, named Environmental Management, including the use of biotechnological tools.

At present, it should be recognized that most State Nature Reserves require considerable investment in the biotechnological activities. These are either non-existent, or use palliative measures that do not yield lasting results, which results in the reduction of the deer population, and, first of all, the roe deer [33].

Thus, small amounts of biotechnological activities, poor diversification of the biotech technologies and their haphazard use at State Natural Reserves of Russia not only fail to contribute to the preservation of the existing biological potential of the wildlife, but are also unable to ensure its reproduction [34-39].

The monitoring analysis of the reasons of the roe deer mass mortality in various regions of Russia in the abnormal conditions of snowy winters has justified the conclusion that the existing complex of biotechnological methods and techniques cannot protect animals from the effects of this extremely harmful factor.

Systematic repetition of these negative episodes and the destructive force of the biological effects build up the logics of understanding the need for new scientific approaches in solving this global problem.

In line with this, at the Kirzinsky Natural Reserve, a program for Siberian roe deer preservation in winter high snow conditions has been developed, based on creating large feeding areas with sunflower, 30 to 50 ha each.

As a result of the scientific monitoring, it was found that during the period of abnormally high snow, the optimal fodder crop for the roe deer was sunflower. For assessing the effect of sunflower on the morphological status of the digestive organs, and confirming the fact of a favorable effect of this crop, three roe deer caught for the research were pathomorphologically examined by a committee of specialists. The pathoanatomical examination was performed according to the standard methods. The results of the examination showed that sunflower inflorescences and fruits had high energy and nutritional value for the animals, created conditions for the active growth and development of the roe deer in the winter high-snow conditions, and for the formation of the fat deposits required for maintaining the activity of the systems of adaptation to the extreme living conditions.

Based on the found regularities in the morphological parameters of the digestive system of the roe deer, a possibility appears to predict the absorption of nutrients from the inflorescence and seeds of sunflower, to calculate and provide the required amounts of the metabolizable energy in the diets of animals, and to purposefully optimize nutrition for ensuring certain level of wild roe deer adaptation to the extreme conditions in their natural habitat in the adverse climatic periods, particularly during the high-snow conditions.

The experiments with the practical use of the selected group of fodder plants for supporting Siberian roe deer in the winter showed that sunflower was the most efficient and affordable biotechnological crop for supporting the roe deer in the critical periods of winter anomalies.

At any height of the snow cover, this crop, while remaining absolutely accessible for wild ungulates, could assist in the most important task of saving, preserving, provision of feed, and keeping large roe deer populations in their winter habitats.

V. CONCLUSIONS

The morphological examination of Siberian roe deer has shown that the use of sunflower as a feed supplement of this species of deer in winters with significant height of the snow cover allows the animals to fully accumulate energy in the amount sufficient for the biological, the morphogenetic, and the metabolic processes in the organism in the period of the most extreme conditions of living in the wild.

NOVELTY STATEMENT

As a result of biotechnological experiments on the cultivation of sunflower for practical use in specially protected natural areas of Russia, new methods and principles for feeding the wintering stock of wild ungulates have been developed, which form the basis of an integrated system of biotechnological measures for the protection and conservation of Siberian roe deer in the conditions of abnormal snow cover.

AOTHOR'S CONTRIBUTION

V.B. Yermolik formulated the study problem, developed the research concept and method, summarized and interpreted the results, which served as the basis for writing the article.

P.N. Smirnov performed a literature review and statistical data analysis.

Yu.D. Schmidt conducted clinical and morphological studies.

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