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NEW INFORMATION ABOUT USING NUTRITIONAL SUBSTANCES BY HUNGERARIAN ANIMALS AT VARIOUS FEEDING TYPES

Abstract. Optimizing the nutrition of various species of ruminant animals, their relationship with different feeding conditions, types of vegetation used in feeding, evaluation of the digestive system will allow you to understand the mechanisms and possibilities for improving feed utilization and increasing the productivity of farm animals, will create the opportunity for keeping wild species in captivity. In the conditions of the SEC "Kharakhussovsky" of the Republic of Kalmykia, we conducted scientific, economic and physiological experiments. The studies were carried out by the method of analog groups on Grozny lambs of sheep from 4 to 8 months of age and on saigas (*Saigatatarica* L.) from 4 to 7 months of age. These two closely related species are attributed to the suborder ruminant (Ruminata) and the bovid family (Bovidae). Feeding animals were divided into 3 groups: hay, hay, and green. In group I of lambs, the share of hay in the diet was 90.9%, saigas - 89.7% of dry matter. In group II, lambs share of haylage is 69.6%, and in saigas it is 67.9%. In the ration of group III, the proportion of green fodder prevailed, so in lambs, grass fodder was 65.8%, and in saigas 62.3%. A high level of nutrient utilization, nitrogen digestibility, elevated levels of volatile fatty acids and total nitrogen in the rumen fluid were found in saigas during green feeding. The relatively low concentration of total nitrogen in the cicatricalsaiga fluid, 37.3 mg%, compared with 39.6 mg% of lambs, indicates a more intensive flow of protein metabolism in them. Young sheep use nutrients better and grow on pretreated feed such as haylage. A high coefficient of nitrogen digestibility was in lambs with hay fever and amounted to 31.03%.

Keywords: lambs, saigas, feeding type, ruminants, digestibility, nitrogen, cicatricial digestion.

Introduction. Optimizing the nutrition of various types of ruminants, their relationship with various feeding conditions, types of vegetation used in feeding, evaluation of digestion will allow you to understand the mechanisms and possibilities of increasing the absorption of nutrients. In addition, the optimization of the feeding level creates opportunities for increasing the productivity of farm animals and the prerequisites for keeping some wild species in captivity [1-6].

Studies of feed adaptations mainly concern separate production groups of animals, although LK Ernst, N.A. Zinoviev [7], J.L. Ellis, J. Dijkstra, A. Bannink [8] noted the need for a deeper study of related species in order to establish the beginning of their food separation in nature and determine the patterns of use of the main types of food resources.

A comprehensive study of the conversion of nutrients by domestic and wild animals, such as sheep and saigas, assigned to the same suborder ruminant (Ruminata) and bovid family (Bovidae) in different feeding conditions is not only of biological, but also of industrial interest [9, 10].

Biological substantiation of complete feeding of animals requires consistent studies of the processes of nutrition, digestion and metabolism [11-14]. Only a uniform tension in the work of a multi-chamber stomach of ruminants at the optimum for this type of combination in the diet of coarse, juicy and concentrated feed can greatly enhance the digestive capacity of the stomach and intestines. As a result, the total digestibility of feeds increases, and their utilization rate increases [15-17].

The aim of the work is to investigate the species differences and the influence of the type of feeding on the digestibility of nutrients and nitrogen, cicatricial digestion, growth rate in growing young sheep and the captive content of saigas.

Materials and methods. To solve the tasks, in the production conditions of the SEC "Kharakhusovsky" of the Republic of Kalmykia, we carried out scientific, economic and balance experiments on young ruminants. The studies were carried out by the method of group analogs on 3 groups of lambs, the Grozny breed of 20 heads each, and on 3 groups of saigas (*Saigatatarica* L.) 7 heads. Growing lambs was carried out with free-range content from 4 to 7 months of age, saigas in aviary conditions from 3 to 7 months of age.

Balance experience was carried out at 7 months of age. From animals that were on scientific and business experience, 3 typical lambs and saigas were selected from each group, which were placed in individual cages. After 10 days of the preparatory period, accounting was carried out for 7 days. At this time, they were fixed individually: the amount of a given feed, its residues, excreted feces and urine per day, and average samples were taken for analysis.

On the last day of the balance sheet experiment, 3 hours after the morning feeding, the cicatricial fluid was taken from the animals using a gastrointestinal probe.

The rations for young sheep were based on the detailed feeding rates of A. P. Kalashnikov et al. [18]. The saigas were fed according to the norms recommended by Yu. N. Arylov [19].

The structure of the rations is given in Table 1. Studies have shown that animals of group I received diets consisting of 90.9% dry matter for lambs and saigas for 89.7% of hay. In group II, lambs had a share of haylage in the diet - 69.6, saiga - 67.9%. Green fodder prevailed in the rations of animals of the third group, in lambs, grass fodder was 65.8%, and in saigas 62.3%.

Table 1 – The structure of the diets of animals by groups, %

Group	Feed	Kind of animal	
		rams	saigas
I	Steppe hay	73,9	69,4
	Alfalfa hay	15,9	18,7
	Grain forage with a complex of mineral additives	10,2	11,9
II	Senazh grass	71,9	70,3
	Alfalfa hay	17,1	18,1
	Grain forage with a complex of mineral additives	10,9	11,6
III	Green feed	71,3	68,0
	Alfalfa hay	17,5	19,5
	Grain forage with a complex of mineral additives	11,2	12,5

The concentration of metabolizable energy in the dry matter of the rations of lambs was different for hay, hay, and green feeding, respectively, 8.34; 8.51 and 8.24 MJ, in young saigas, respectively, 8.48; 8.58 and 8.32 MJ. To compensate for the deficit of macro and microelements, a complex of mineral substances consisting of monosodium phosphate, magnesium carbonate, feed sulfur, copper sulfate, zinc carbonate, and potassium iodide was introduced into the concentrated feed of all groups of animals. In samples of feed, their residues and feces, the total humidity was determined, the ash content was determined by burning, and crude fat was determined according to S.V. Ruskowski, raw fiber - according to Genneberg and Shtoman. The amount of nitrogen in the samples was determined on a semi-automated complex to determine nitrogen and protein by the Kjeldahl method.

The content of the rumen was determined by the total amount of volatile fatty acids by the method of steam distillation in the apparatus of Markgam, the amount of total nitrogen by the Kjeldahlmicromethod, protein nitrogen by the Barnstein method, residual nitrogen by the calculation method by the difference between total and protein, pH on a pH-150M millivoltmeter.

The data obtained during the experiments were processed using mathematical methods of variation statistics using the Microsof Excel software.

Results. A comparative assessment of various species of ruminants, carried out by us, shows that the species differences in the digestion of food are more significant than the similarity determined by the same type of food.

The main factors affecting the metabolism of nitrogen in the digestive tract are the quality of the nitrogen source and the degree of availability of high-value plant proteins. The percentage of assimilation of raw protein and fat from feed rations in various animal species indicates an increased absorption of metabolites in the rumen (figure 1).

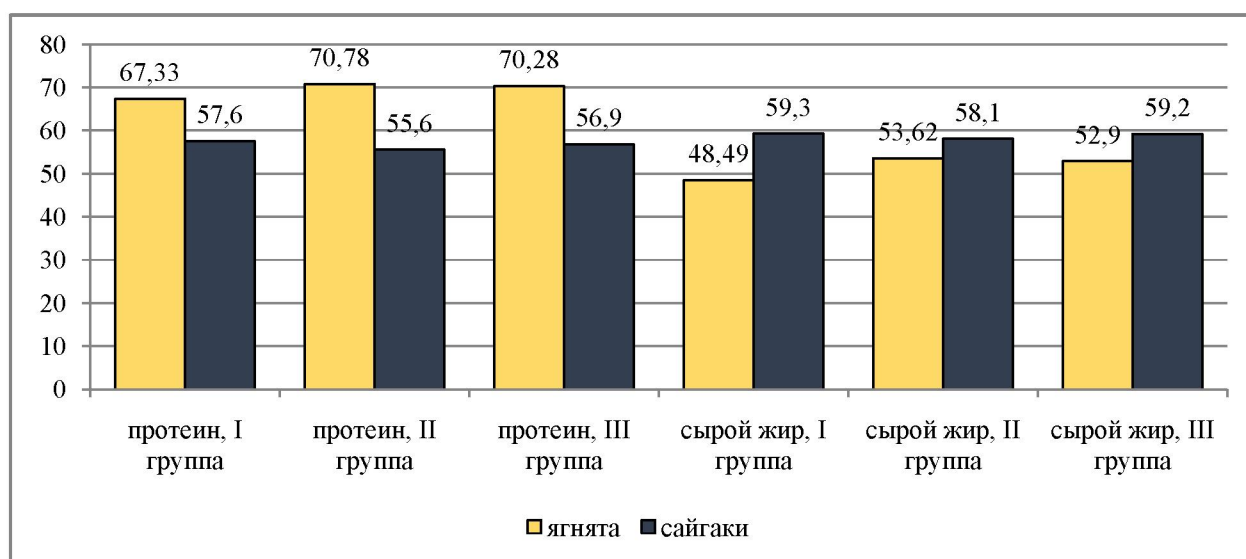


Figure 1 – The coefficients of digestibility of raw protein and fat, %

Saigas of group III, who received a green ration, surpassed peers from group II, in the assimilation of crude protein by 1.30; raw fat by 1.10%. As a result of the intensive protein metabolism of diets in the body of young sheep, they consumed better and digested the protein during hay feeding in comparison with saigas by 15.18%. However, saigas better digested the crude fat contained more in the rations for hay and green feeding types compared with lambs by 11.11 and 7.18%, respectively.

Saiga young, characterized by greater motor activity, regardless of the type of feeding, compared with lambs, absorbed raw fat, which has a high energy content. Proteins in the body of animals are mainly used for the growth and renewal of cells and tissues. At the same time, the protein utilization ratio of the rams was higher compared to saigas. In our opinion, this is caused by the species characteristics of animals.

Differences in feeding types have a significant effect on the digestion and deposition of nitrogen in the body in all ruminant species.

In the course of our research, it was found that in terms of deposition and the percentage of nitrogen utilization, the best lambs of group II were fed the hay diet (figure 2). Lambs that received hay feeding type (group II) in their body laid off more nitrogen compared to lambs that consumed hay feeding type (group I) by 0.76 g. It should be noted that young sheep who consumed green type feeding (group III) also exceeded the lambs that received hay feeding (group I) by 0.63 g.

Experimental saigas of group III who received the green type of feeding laid off more nitrogen in their bodies than their peers from groups II and I by 15.0 and 8.7%, respectively.

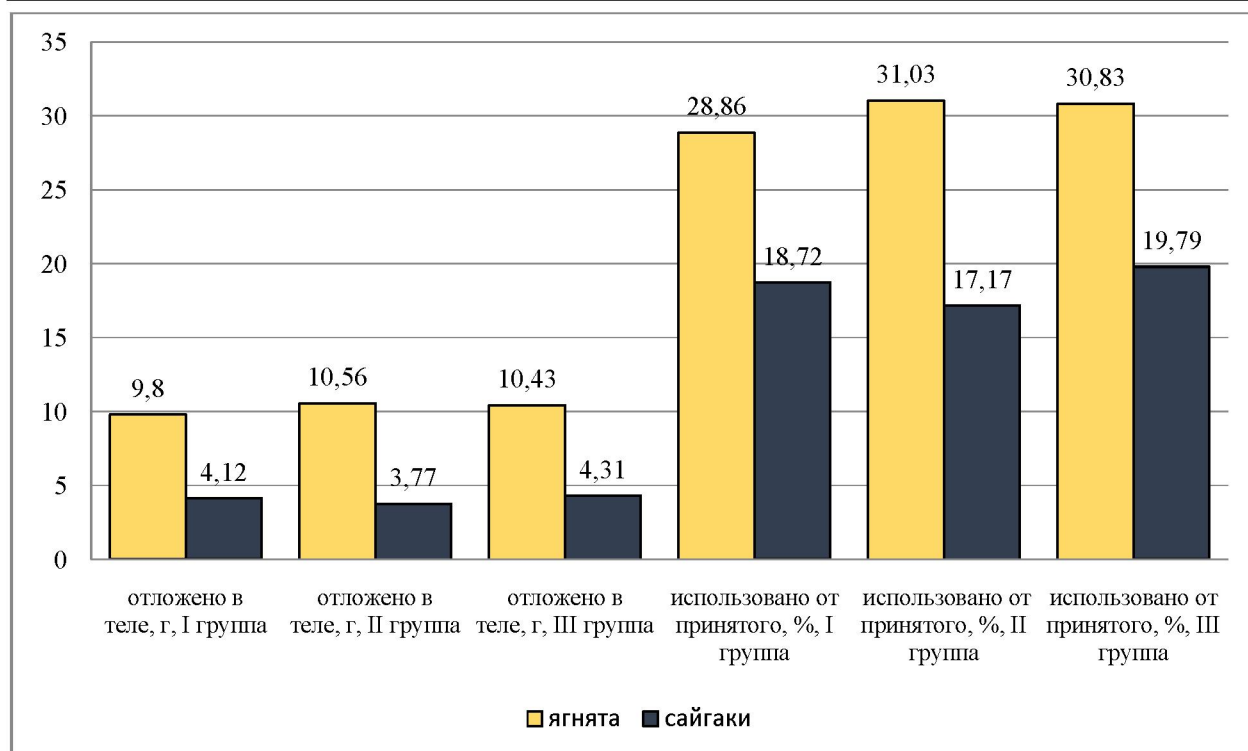


Figure 2 – Deposition in the body and the coefficient of nitrogen digestion

The degree of assimilation of nitrogen by the body and the intensity of nitrogen metabolism in the digestive tract of ruminants more accurately reflects the utilization rate of this element. The percentage of nitrogen used from feed taken in lambs of group II, who received a haylage ration, was 2.17% more compared with their peers of group I, who received the hay ration.

Saiga juveniles from group III, who received a green ration, surpassed in their utilization of nitrogen their peers from Group II at 2.62%, consuming hay diet. However, the percentage of nitrogen used in hay-fed feeding of lambs was higher by 13.86% compared to saigas.

The reason for the variability of the digestibility of the basic nutrients of diets during different types of feeding, apparently, is the change in the secretion of the digestive glands and microbiological processes occurring in a multi-chamber stomach of various species.

Biochemical indicators of cicatricial fluid can serve as its indicators and reflect the metabolic processes occurring in the body of animals. We have evaluated species peculiarities of nitrogen metabolism in the rumen of lambs and saigas (table 2).

Table 2 – Indicators of cicatricial metabolism

Indicators	Norm	Group		
		I	II	III
Lambs				
pH	6,1-6,9	6,63±0,39	6,12±0,22	6,35±0,38
Total nitrogen, mg%	30-48	44,6±0,82**	47,5±1,1***	43,7±1,01
Residual nitrogen, mg%	—	13,3±0,21**	12,4±0,13*	11,2±0,23
ЛДЖК, мТЭКВ/100мл	10-20	13,24±0,38*	18,32±0,31***	15,67±0,42**
Saigas				
pH	—	6,71±0,41	6,62±0,17	6,17±0,18
Total nitrogen, mg%	—	38,9±0,9	37,3±0,61	45,8±0,82
Residual nitrogen, mg%	—	16,3±0,38	14,7±0,65	12,3±0,41
ЛДЖК, мТЭКВ/100мл	—	11,61±0,22	12,24±0,16	17,82±0,33

Table 3 – Dynamics of body weight of animals

Indicators	Group		
	I	II	III
Lambs			
Live weight, 4 month	25,80±0,69	26,20±0,88	26,20±1,18
7 month	35,85±1,22	39,69±1,12**	39,24±1,09**
Absolute gain, kg	10,02±1,10	13,49±1,09*	13,04±0,90
Average daily gain, gr.	111,33±12,18	149,93±12,12*	144,89±10,06
Saigas			
Live weight, 3 month	12,83±0,30	12,94±0,31	12,60±0,42
7 month	18,57±0,67	18,20±0,69	19,27±0,66
Absolute gain, kg	5,74±0,63	5,26±0,64	6,67±0,49
Average daily gain, gr.	47,83±5,24	43,83±5,32	55,59±4,06*

The high level of protein digestion in lambs with senazhny type of feeding allowed to get from the group II by 3.47 kg ($P < 0.05$) the absolute increase more than from peers from group I (table 3).

The use of herbal rations in feeding saigas made it possible to obtain, during the test period, 6.67 kg increase in live weight, which is 1.41 kg higher than when grown on hay rations. In absolute and average daily gains, the live weight of the lambs significantly exceeded the saigas during all types of feeding. So, when grown on hay diets, average daily gains of lambs were 3.4 times higher, and with green type of feeding, 2.6 times higher.

The growth intensity of the compared groups of young for a certain period characterizes the relative increase. A comparative assessment of the relative increase in live weight of animals over the period of experience generally reflects the peculiarities of nutrient utilization by different types of ruminants for different types of feeding (figure 3).

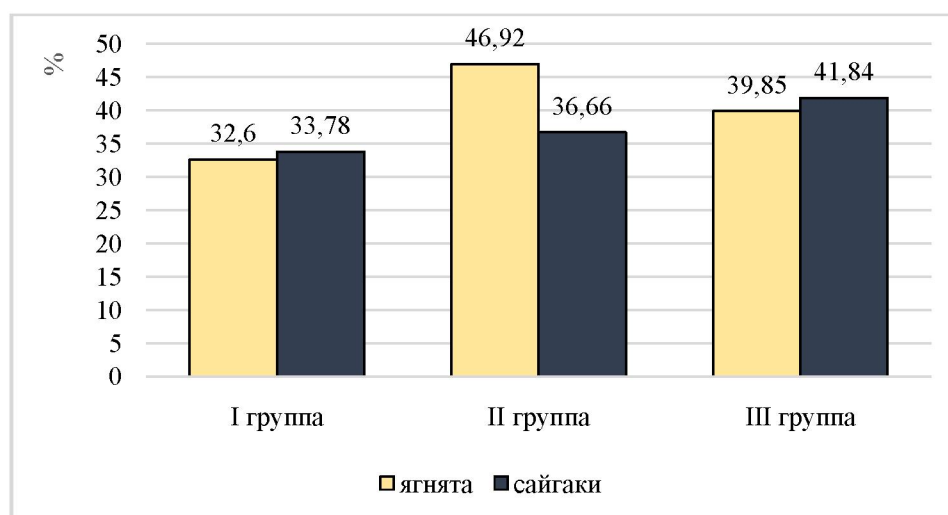


Figure 3 – The relative increase in animals over the period of experience

The growth rate of young sheep depended on the composition of the diets, so with the haylage type of feeding, it was 46.92% and was higher by 14.32% than with the hay. At the same time, the difference in growth among these groups of saigas was 8.06%.

Conclusions. Thus, the development of an animal and, consequently, its mass is not determined solely by the amount of energy supplied daily with food, but is closely related to the type of animal, the composition of the diet, and feeding conditions. Higher levels of nutrient utilization, nitrogen digestibility, volatile fatty acid concentrations and total nitrogen in the rumen fluid in saigas during green feeding. As a

result, the growth rate of saigas when grown on grass rations is much higher than on hay and hay rations. Young sheep use nutrients better and grow on feeds from pretreatment, such as haylage. Consideration of the identified features of the use of feed rations by various species of ruminant animals is necessary for the development of diets and feeding techniques that allow realizing the genetic potential of the productivity of farm animals and the adaptation of wild species to captive conditions.

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КҮЙІСКАЙЫРАТЫН ЖАНУАРЛАРДЫ ӨРТҮРЛІ АЗЫҚТАНДЫРУЫНДА ҚОРЕКТІК ЗАТТАРДЫ ПАЙДАЛАНУ

Аннотация. Күйіскайыратын жануарлардың әртүрлі түрлерін азықтандыруын онтайландыру, азықтандырудың әртүрлі жағдайларымен байланысын, азықтандыруда пайдаланылатын өсімдіктердің түрлерін, асқорыту стратегиясын бағалау, жем-шөпті пайдаланудың арту мен ауылшаруашылық жануарларының өнімділігін арттыру механизмдері мен мүмкіндіктерін түсінуге және жабайы түрлерді қолға ұстауға мүмкіндік береді. Қалмақ Республикасының «Харахусовский» ӨКК жағдайында біз ғылыми-өндірістік және физиологиялық эксперименттер жүргіздік. Зерттеулер аналогтық топ әдісі бойынша Грозный тұқымдық қойларының 4-8 айлық қозылары мен 4 айдан 7 айға дейін ақбөкендерге (*Saiga tatarica* L.) жүргізілді. Бұл екі тығыз байланысты түрлер күйіскайыратын ішкі топқа (Ruminata) және қуысмүйізділер тұқым тобына жатады. (Bovidae) Жануарларды азықтандыру түрлері 3 топқа бөлінді: шөпті, сүрлім шөп және жасыл шикізатты. I топтағы қозылардың шөпті азық құрамында құрғақ заттардың – 90,9%, ақбөкендерде – 89,7%. II топта қозылардың азығында сүрлем шөптің үлес салмағы – 69,6%, ақбөкендерде – 67,9% құрайды. III топтағы азық себетінде жасыл шикізаттың үлес салмағы көп болды, қозыларда шөп азығына – 65,8%, ал ақбөкендерде – 62,3%. Жануарлардың даму мөлшері, сондықтан оның массасы күнделікті азық-түлікпен қамтамасыз етілетін қуат мөлшерімен анықталмайды, бірақ жануардың түрі рационның құрамы және оны азықтандыру жағдайымен тығыз байланысты. Ақбөкендерде жасыл шөппен тамақтандыру кезінде қоректік заттардың жоғары деңгейі, азот сіну қабілеті, ұшпа май қышқылдарының жоғары деңгейлері және таз қарынның сұйықтығындағы азоты жалпы мөлшері анықталды. Ақбөкеннің тыртықты сұйықтығындағы жалпы азоттың концентрациясы 37,3 мг % қозылармен салыстырғанда 39,6 мг % және жоғары қалдық азоттың ақуыз алмасуының қарқынды жүруін көрсетеді. Қойдың төлдері сүрлем шөп сияқты қоректік заттарды жақсы пайдаланады. Азотты пайдалану пайызы II топтағы қозылардың I топтан 2,17%-ға және III топтан 0,20%-ға көп. Азоттың сіңірілуінің жоғары коэффициенті сүрлем шөп тамақтандыру түрінде қозыларда – 31,03% құрады.

Түйінді сөздер: қозылар, ақбөкендер, азықтандыру түрі, күйіскайыратын жануарлар, сіңімділік, азот, тыртықты ас қорыту.

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НОВЫЕ СВЕДЕНИЯ ПО ИСПОЛЬЗОВАНИЮ ПИТАТЕЛЬНЫХ ВЕЩЕСТВ ЖВАЧНЫМИ ЖИВОТНЫМИ ПРИ РАЗЛИЧНЫХ ТИПАХ КОРМЛЕНИЯ

Аннотация. Оптимизация питания различных видов жвачных животных, их взаимосвязь с различными кормовыми условиями, типами растительности, используемыми в кормлении, оценка системы пищеварения позволит понять механизмы и возможности улучшения использования кормов и увеличения продуктивности сельскохозяйственных животных, создаст возможность для содержания диких видов в неволе. В условиях СПК «Харахусовский» Республики Калмыкия нами были проведены научно-хозяйственный и физиологический опыты. Исследования проводили методом групп-аналогов на ягнятах грозненской породы овец от 4 до 8 месячного возраста и на сайгаках (*Saiga tatarica* L.) от 4 до 7 месячного возраста. Эти два близкородственных вида, отнесены к подотряду жвачные (Ruminata) и семейству полорогие (Bovidae). Животные по типу кормления были разделены на 3 группы: сеной, сенажный и зелёный. У I группы ягнят удельный вес сена в рационе составлял – 90,9%, сайгаков – 89,7% по сухому веществу. Во II группе ягнят удельный вес сенажа – 69,6%, у сайгаков – 67,9%. В рационе III группы преобладал удельный вес зелёных кормов, так у ягнят травяные корма составляли – 65,8%, у сайгаков – 62,3%. Высокий уровень использования питательных веществ, перевариваемости азота, повышенный уровень концентрации летучих жирных кислот и общего азота в рубцовой жидкости выявлен

у сайгаков при зеленом типе кормления. Относительно низкая концентрация общего азота в рубцовой жидкости сайгака 37,3 мг% по сравнению с ягнятами 39,6 мг%, указывает на более интенсивное протекание у них белкового обмена. Молодняк овец лучше использует питательные вещества и растет на кормах подвергшихся предварительной обработке, таких как сенаж. Высокий коэффициент переваримости азота был у ягнят при сенажном типе кормления и составил 31,03 %.

Keywords: ягнята, сайгаки, тип кормления, жвачные животные, переваримость, азот, рубцовое пищеварение.

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REFERENCES

- [1] Clauss M., Hummel J. The digestive performance of a mammalian herbivores: why not so much better // *Mammal Rev.*, 2005, 35: 174-187 (doi: 10.1111/j.1365-2907.2005.00062.x).
- [2] Kokshunova, L.E., Gavrilenko B.C., Treus M.Yu. Relationship saiga with wild and domestic animals // *Journal of Evolutionary Biochemistry and Physiology*, 2005, 6: 202-207.
- [3] Chamurliov N.G., Chapurkina O.V., Filatov A.S. Feeding and fattening of young sheep of the Volgograd breed at different levels of protein // *News of the Nizhnevolzhskaya grouduniversity complex: Science and higher professional education*, 2013, 1-1 (29): 127-131.
- [4] Semenov V.G., Baimukanov D.A., Kosyaev N.I., Alentayev A.S., Nikitin D.A., Aubakirov Kh. A. Activation of adaptogenesis and bioresource potential // *The National academy of sciences of Kazakhstan*, 2019, 1: 175-189. ISSN 2518-1467 (doi: 10.32014/2019.2518-1467.20).
- [5] Semenov V.G., Baimukanov D.A., Kosyaev N.I., Mudarisov R.M., Morozova N.I., Musayev F.A., Nikitin D.A., Kalmagambetov M.B. It has been shown that this is the case // *Bulletin of the Republic of Kazakhstan*, 2018, 2: 22-34. ISSN 1991-3494.
- [6] Ernst L.K., Zinovyeva N.A. Biological problems of livestock in the XXI century. M., 2008. 508 p.
- [7] Ellis J.L., Dijkstra J., Bannink A., Kebreab E., Hook S.E., Archibeque S.J., France J. Quantifying the beef cattle // *Journal of Animal Science*, 2012, 90 (8): 2717-2726.
- [8] Campos-Parra J., De Pedro-Sanz E., Iturriaga-Astorga D., Astudillo-Neira R., Basso-Basso I., Cabas-Monje J., Carro M.D., Ungerfeld E.M. Utilization of organic acids to manipulate ruminal fermentation and improve ruminant productivity // *Rumen Microbiology: From Evolution to Revolution*, 2015: 177-197.
- [9] Sarsenova B.B., Arylov Yu.N., Usenov Zh.T. The study of saiga young stock of the Ural population in captivity. *Science News of Kazakhstan*, 2013, 3: 133-137.
- [10] Bogolyubova N.V., Romanov V.N., Devyatkin V.A., Gusev I.V., Bagirov V.A., Zinovyeva N.A. Biological parameters of digestive and metabolic processes in interspecific hybrids of domestic sheep (ovisaries) and argali (ovis ammon polii) // *Agricultural Biology*, 2016, 4 (51): 500-508. (doi: 10.15389/agrobiology.2016.4.500rus)
- [11] Kühl A., Mysterud A., Grachev Iu.A., Bekenov A.B., Ubushaev B.S., Lushchekina A.A., Milner-gulland E.J. Monitoring population productivity in the saiga antelope // *Animal Conservation*, 2009, 4 (12): 355-363. (doi: 10.1111/j.1469-1795.2009.00260.x)
- [12] Sales J., Jančík F., Homolka P. Quantifying differences in total nutrient digestibilities between goats and sheep // *J. Anim. Physiol. Anim. Nutr.*, 2007, 96 (4): 660-670 (doi: 10.1111/j.1439-0396.2011.01194.x).
- [13] Clauss M., Hofmann R.R., Streich W.J., Fickel J., Hummel J. Convergence in the wild species of different feeding types and the new resulting hypothesis // *J. Zool.*, 2010, 281 (1): 26-38 (doi: 10.1111/j.1469-7998.2009.00675.x)
- [14] Jetana T., Tasripoo K., Vongpipatana C., Kitsamra S., Sophon S. Brahman cattle // *Anim. Sci. J.*, 2009, 80 (2): 130-139 (doi: 10.1111/j.1740-0929.2008.00618.x).
- [15] Rius A.G., Kittelmann S., Macdonald K.A., Waghorn G.C., Janssen P.H., Sikkema E. Nitrogen metabolism and rumen with high-level digestibility pasture // *J. Dairy Sci.*, 2012, 95: 5024-5034 (doi: 10.3168/jds.2012-5392).
- [16] Pino F., Heinrichs A.J. Effect of trace elements, starch digestibility, and rumen fermentation in diets for dairy heifers // *J. Dairy Sci.*, 2016, 99 (4): 2797-810 (doi: 10.3168/jds.2015-10034).
- [17] Norms and diets for feeding farm animals: Reference Guide / Ed. A.P. Kalashnikova, V.I. Fisina, V.V. Scheglova, N.I. Kleimenov (2003): 456. ISBN 5-94587-093-5.
- [18] Arylov Yu.N. (2002) Scientific Aspects of Nutrition and the Development of Saigas in Captivity. Dis ... Dr. biol. PhD.: 03.00.04; February 6, 2002 Dubrovitsy: 284.