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THE CONFORMATION OF LATVIAN WARMBLOOD CARRIAGE TYPE STALLIONS OF SPEKONIS SIRE LINE AND THEIR PROGENY

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ABSTRACT

In the breeding of Latvian Warmblood carriage type horses, one of the major breeding objectives is producing of typical purebred animals with minimal influence of modern warmblood breeds. The sire line of Spekonis is most widely represented nowadays. The aim of the study was to compare the quality of the Latvian Warmblood carriage type stallions of Spekonis sire line by their own conformation and the conformation of progeny. The data of 12 actual Latvian Warmblood horse carriage type stallions of Spekonis sire line were analyzed. The conformation evaluation data from 33 offspring and the description of conformation from 23 offspring of 4 stallions were collected.

The analysis of the origin of Spekonis sire line stallions showed that the stallions came from three founder's sons and it was advisable to maintain a division in three branches hereafter. The analysis of the conformation traits of all progeny showed that the representatives of the sire line had dry constitution, harmonic conformation, well-developed ligaments, proportional head with straight profile, wide jowls and expressive eyes, moderate long and straight neck, therefore a large number of progeny had a base-narrow limb position and toeing-out of forelimbs and hind limbs. There were significant differences ($P < 0.05$) between the progeny of stallions for the length of back and neck, croup slope and oval croup, width of chest and good development of hock joints, whereas the progeny of stallion Sidrabs were more qualitative, although having such conformation faults as toeing-out and a trend to put legs narrow both for forelimbs and hind limbs and swing outwards.

Keywords: *Latvian Warmblood, carriage type, stallions, Spekonis sire line, conformation*

INTRODUCTION

The Latvian Warmblood horse breed is divided into sport and carriage types. The preservation of the carriage type started in 2004 with the aim to preserve genetic resources of livestock. The main breeding objective for the Latvian Warmblood carriage type horse is to produce purebred horses with a steady temperament, suitable for tourism, hobby class riding, driving, riding therapy.

Historically Latvian Warmblood horses were used for universal purposes, both riding and farm work. Due to several warmblood breeds that were used for improving jumping and gait characteristics, Latvian Warmblood horse became lighter. The development of the sport type is based on horses breeding for show jumping and dressage. There are stallions of related breeds widely used to reach the breeding aim. The breeding program of carriage type horses was worked out in 2004. If the horses are accepted as appropriate for the breed's genetic resources, they must conform to several criteria. The most important criterion – the origin of the horse. Currently, one of the major breeding objectives in breeding of carriage type horses is producing typical purebred animals with minimal influence of modern warmblood breeds. A steady temperament, easiness of handling and a strong body conformation are desirable features for carriage type horses [8]. Recently the number of carriage type horses has increased, and also, the demand for well-trained purebred carriage type horses is growing.

There were 38 Latvian Warmblood carriage type stallions included in the catalogue of licensed stallions for 2013/2014 breeding season [6]. The stallions had various origins; the line of Spekonis was the most widely represented with 12 stallions. It was reasonable to analyze these stallions more critically to choose the sires with the best qualities and most suitable for reaching the breeding goals the carriage type.

The founder of this sire line was the Groningen breed stallion Spekonis Lsb100 (original name – Imperator 127). The representatives of this sire line were exhibited in horse shows more often than from other lines (35 % of all horses between 1954 and 1989). The son of Spekonis – Stars – got a nomination of the absolute champion of the main horse show in the Soviet Union. The most award-winning horses were from the line of Spekonis – 14 horses got a nomination of a winner or a record holder of all-union show, most of them were the representatives of „gold-cross” of lines of Spekonis and Gotenfirsts. The horses from Spekonis sire line were successful also in all-union carriage horse tests [9, 10].

Performance is the basic horse productivity. Quality, durability and efficiency of performance are closely related to conformation. Conformation is physical appearance of an animal according to the arrangement of muscles, bones and other tissues. Conformation is determined as the most important, second or third major selection criteria in breeding programs of almost all breeding organizations of warmblood horses [2, 4]. Conformation influences reliability of horse limbs and quality of gaits, and lameness

frequently occur due to a less than ideal joint and limb angulation [5]. As a methodology of horse valuation, the Breeding Program of Latvian Warmblood Horse schedules seven conformation criteria. Each criterion should be evaluated on a ten point scale [1]. There was no detailed description of the conformation included in the evaluation methodology for more than ten years, and there was no possibility to determine the quality of conformation of each animal and the whole population. The evaluation on a ten point scale hides many parameters as faults and advisable conformation traits, and it is also subjective because of various experts [7]. The evaluation form, prepared in 2010, defines recording of every conformation trait. Similar conformation descriptions can be obtained using linear evaluation score [3].

The aim of the study was to compare the quality of Latvian Warmblood carriage type stallions of Spekonis sire line by their own conformation and conformation of their progeny.

MATERIALS AND METHODS

The data of 12 actual Latvian Warmblood carriage type stallions of Spekonis sire line have been analyzed (licensed for 2013/2014 breeding season). The data included the records of conformation quality of stallions and their progeny – valuation of seven conformation criteria and description of conformation traits. The conformation valuation data from 33 offspring and description of conformation from 23 offspring of 4 stallions were collected (Table 1).

Table 1. Age and number of foals of stallions from Spekonis sire line of Latvian Warmblood horse breed				
Name of stallion	Year of birth	Total number of foals	Number of evaluated foals	Number of foals with description of conformation
Delevars	2007	0	0	0
Domino	2010	2	0	0
Sagapo	2004	15	2	2
Santoss	2007	4	0	0
Severins	2006	4	0	0
Sidrabs	2005	20	9	8
Simbols	2005	5	0	0
Simmons	2006	2	0	0
Sirijs	2006	0	0	0
Sprinters	1994	13	7	4
Sulainis	2003	3	0	0
Sultans	1998	61	15	9

The Latvian carriage type stallions were evaluated in accordance with the Breeding Program of Latvian Warmblood Horse [1]. Conformation valuation included seven conformation criteria – type, top line of horse (head, neck, withers, shoulder, back, loins, and croup), width of body, conformation of forelimbs, conformation of hind limbs, correctness of movement and temperament – valued on a ten point scale.

The information about the pedigree of stallions, their conformation valuation and conformation valuation of their progeny was found in Stud Book and public horse database of Latvian Horse Breeding Association, available at: www.lwhorse.lv.

The description of conformation traits of stallions and their progeny were found in public horse database of Latvian Horse Breeding Association. The expression of conformation traits was not recorded, except for the development level (good, moderate, low) of several traits.

The statistical analysis was performed using IBM SPSS Statistics 20. The data were analyzed using nonparametric nominal data descriptive statistic method Crosstabs. The significance of the differences between the groups was assessed using Chi-square and one-way analysis of variance ($P < 0.05$).

RESULTS AND DISCUSSION

Twelve Latvian Warmblood carriage type stallions of Spekonis sire line were licensed for the 2013/2014 breeding season.

The analysis of the origin of the stallions of Spekonis sire line showed (Table 2) that the stallions came from three founder's sons – Selis, Sudrabs and Stradnieks. Stradnieks was a champion of the main horse show of the Soviet Union in 1967, and this branch has been developing till now through his son Sprincis and grandsons Staldzis and Saimnieks. The other branch developed from Sudrabs' son Stiprais and two grandsons Stasis and Sigo. Stiprais was a record holder of the breed in maximal tractive force, Stasis – champion of the all-union show. Sigo had also succeeded in carriage horse tests. The third branch developed from founder's grandson Dailis, a stallion of high quality, through his best son Dolars [9; 10]. Due to different origin of stallions, it was recommended to maintain the division in three branches hereafter with the aim to preserve the diversity of the breed's carriage type.

Sixteen-years old stallion Sultans is at present the most widely used stallion from this sire line having 61 registered offspring, 3 of them – licensed stallions. Two stallions from Spekonis sire line have had no progeny yet, stallions had only unevaluated progeny (the majority of them had not reached the age of evaluation), and therefore, 8 stallions could not be evaluated by the progeny quality (Table 1).

The quality of progeny was analyzed in 4 stallions – Sagapo, Sidrabs, Sprinters and Sultans. The youngest stallion was Domino (4 years old), the majority of stallions were born between 2003 and 2007. The oldest stallion was Sprinters (20 years old). It should

Table 2. Development of Latvian Warmblood horse Spekonis sire line from founder till licensed stallions in 2014							
Generations							
Licenced stallions	2	3	4	5	6	7	8
Delevars	Delfins LS1667	Demons	Donors L1078	Dolars L1000	Dailis Lb694	Selis Lb443	Spekonis Lsb100
Domino	Despots L1293	Draguns L1239	Dolars L1000	Dailis Lb694	Selis Lb443	Spekonis Lsb100	
Sagapo	Samts L1359	Stasis L1185	Stiprais L725	Sudrabs Lb273	Spekonis Lsb100		
Sidrabs	Samts L1359	Stasis L1185	Stiprais L725	Sudrabs Lb273	Spekonis Lsb100		
Sprinters	Sambo L1300	Sigo L1127	Stiprais L725	Sudrabs Lb273	Spekonis Lsb100		
Santoss	Sultans LS1591	Stiprums L1385	Sazans L1099	Saimnieks L1462	Sprincis Lb741	Stradnieks Lb675	Spekonis Lsb100
Severins	Sarmis L1369	Staldzis L1055	Sprincis Lb741	Stradnieks Lb675	Spekonis Lsb100		
Simbols	Sarmis L1369	Staldzis L1055	Sprincis Lb741	Stradnieks Lb675	Spekonis Lsb100		
Simmons	Sarmis L1369	Staldzis L1055	Sprincis Lb741	Stradnieks Lb675	Spekonis Lsb100		
Sirijs	Sultāns LS1591	Stiprums L1385	Sazans L1099	Saimnieks L1462	Sprincis Lb741	Stradnieks Lb675	Spekonis Lsb100
Sulainis	Sultans LS1591	Stiprums L1385	Sazans L1099	Saimnieks L1462	Sprincis Lb741	Stradnieks Lb675	Spekonis Lsb100
Sultans	Stiprums L1385	Sazans L1099	Saimnieks L1462	Sprincis Lb741	Stradnieks Lb675	Spekonis Lsb100	

be noted that 3 of 4 stallions, used more intensively for breeding purpose, were representative of Sudrabs' branch.

The average valuation of conformation for the type of the stallions of Spekonis sire line was 7.93 ± 0.16 , for the top line of the horse – 7.95 ± 0.10 , for body width – 7.45 ± 0.18 , for conformation of forelimbs – 6.99 ± 0.14 , for conformation of hind limbs – 7.03 ± 0.16 , for correctness of movement – 7.38 ± 0.14 and for temperament – 7.92 ± 0.26 . The average height at withers of the stallions was 166.3 ± 1.2 cm, average circumference of chest – 195.7 ± 1.7 cm and average cannon circumference – 23.18 ± 0.26 cm. In comparison, the average measures of purebred Latvian Warmblood elite class stallions of Spekonis sire line in 1981 were 162.8 cm in withers height, 196.5 cm in circumference of chest and 22.89 cm in cannon circumference.

The comparison of individual stallions from the Spekonis sire line showed that stal-

lion Simmons had the highest total valuation of conformation (55.5 points). Two stallions – Sagapo and Sulainis – also had the high total valuation – 50 points both. The stallion Delevars was also highly evaluated – 8 points for each trait except for forelimbs and type (total valuation – 54 points), because this stallion was of light carriage horse type, close to sport type and the influence of Thoroughbred, Hanoverian and Trakehner breeds in its origin. The lowest valuation was determined for stallion Sidrabs (49 points) due to low points for width of body and quality of forelimbs (6 points). Santoss and Severins were both scored 50 points for conformation. Severins also had the lowest score of hind limbs (6 points). A top line of body was highly evaluated for all stallions, only Santoss got 7 points for this trait. A significant difference in conformation quality among stallions was not found.

The differences in valuation of conformation on a ten-point scale are shown in Table 3.

Table 3. Valuation of conformation of progeny of Latvian Warmblood carriage type stallions from Spekonis sire line							
Group of progeny	Valuation of conformation, points						
	Type	Top line	Width of body	Forelimbs	Hind limbs	Correctness of movement	Temperament
All	7.50 ± 0.11	7.18 ± 0.11	7.49 ± 0.13	6.70 ± 0.11	6.82 ± 0.11	6.94 ± 0.12	7.74 ± 0.13
Sagapo	7.00 ± 0.00	7.00 ± 0.00	7.50 ± 0.50	6.50 ± 0.50	7.50 ± 0.50	7.00 ± 1.00	7.00 ± 1.00
Sidrabs	7.56 ± 0.18	7.33 ± 0.17	7.56 ± 0.29	6.89 ± 0.26	7.00 ± 0.24	7.00 ± 0.24	7.56 ± 0.29
Sprinters	7.71 ± 0.18	7.29 ± 0.21	7.71 ± 0.29	6.36 ± 0.09	6.43 ± 0.17	6.57 ± 0.13	7.92 ± 0.07
Sultans	7.43 ± 0.19	7.07 ± 0.20	7.33 ± 0.19	6.77 ± 0.15	6.80 ± 0.14	7.07 ± 0.17	7.87 ± 0.19

There was a no significant difference in conformation quality among the groups of progeny of different stallions.

The analysis of the conformation traits of all progeny showed that dry constitution was recorded for 47.8 % of horses from Spekonis sire line, harmonic conformation – for 56.5 %, long body – for 13 %, well-developed muscles – for 30.4 %, moderate developed muscles – for 39.1 %, well-developed ties – for 34.8 %, moderately developed ties – for 30.4 %.

The most characteristic conformation traits of the top line are shown in Table 4. As it can be seen, proportional head with straight profile, wide jowls and expressive eyes, moderate long and straight neck were characteristic of the progeny of Spekonis sire line stallions without external deviations from the normal conformation of top the line. It should be noted that there was a considerable number of horses with long and concave back in the sire line of Spekonis. Significant differences have been found between the progeny of different stallions for the long back ($P < 0.05$) because a large number of

offspring of Sagapo and Sidrabs had this trait. A long neck was also a characteristic trait of the progeny of Sidrabs ($P < 0.05$). There were differences between the groups also in the shape of croup – for slope croup and oval croup ($P < 0.05$).

Table 4. Most characteristic conformation traits of top line of progeny of Latvian Warmblood stallions from Spekonis sire line

Description of conformation criteria	Frequency of each trait in valuations of progeny	Description of conformation criteria	Frequency of each trait in valuations of progeny
Proportional head	0.522	Low withers	0.130
Large head	0.130	Long shoulder	0.304
Moderate jowls	0.304	Moderate shoulder	0.348
Wide jowls	0.478	Moderate slope shoulder	0.478
Straight profile	0.609	Standup shoulder	0.087
Expressive eyes	0.348	Long back	0.261
Large eyes	0.130	Moderate back	0.348
Moderate eyes	0.261	Straight back	0.348
Long neck	0.217	Concave back	0.304
Moderate neck	0.435	Long loin	0.217
Short neck	0.087	Moderate loin	0.391
High-standing neck	0.304	Straight loin	0.391
Moderate standing neck	0.348	Cranked loin	0.130
Moderate poll	0.348	Long croup	0.174
Straight neck	0.478	Moderate croup	0.435
Long withers	0.217	Normal croup	0.478
Moderate long withers	0.391	Slope croup	0.174
Moderate high withers	0.522	Oval croup	0.565

The offspring of Spekonis sire line stallions had moderate (47.8 % of all records) to wide (26.1 %) and moderate deep (30.4 %) to deep (34.8 %) chest, as we found significant differences between the progeny of stallions in chest width ($P < 0.05$). A wide chest is a characteristic trait of the offspring of Sidrabs and Sprinters. 39.1 % of all progeny had records of moderate croup, 17.4 % – of wide croup.

The offspring of stallions were with mainly correct position of forelimbs and hind limbs (52.2 % of all records), therefore 26.1 % of progeny had base-narrow position of forelimbs and hind limbs and almost half (47.8 %) of all offspring of Spekonis sire line stallions had records of toeing-out of forelimbs, the difference between the stallions was not significant. Toeing-out of hind limbs was characteristic of 39.1 % of progeny. 21.7 % of offspring had long foreleg, 30.4 % – moderate foreleg. 43.5 % of the offspring had records of well-muscled foreleg. This was a characteristic trait of the progeny of Sidrabs,

however, the difference was not significant. In general, development of forelimbs of all the horses in Spekonis sire line was found as good with well-developed canons, fetlocks and flexor tendons, good hoofs, 43.5 % of progeny had records of moderate developed knees, 21.7 % – of sloping pasterns. A significant difference ($P < 0.05$) between stallions was found in good development of hock joints – the progeny of Sidrabs had significantly higher results while the progeny of Sultans often had records of moderate developed hock joints, however, the difference for this trait was not significant. The progeny of Sultans also had records of long and sloping pasterns of hind limbs. The condition of hooves of hind limbs was good; hooves were mostly correct and firm. The offspring of Sidrabs showed worse results in correctness of movement, having a trend to put legs narrow both for forelimbs and hind limbs and swing outwards, nevertheless, a significant difference was not found.

The description of the progeny of each stallion is shown in Table 5.

Table 5. The characteristic traits of progeny of Latvian Warmblood carriage type stallions from Spekonis sire line		
Stallion	Number of foals with description of conformation	Characteristic conformation traits
Sagapo	2	Moderate jowls, slope and oval croup, toeing-out of forelimbs and hind limbs, moderate developed knees, well-developed canons of hind legs.
Sidrabs	8	Harmonic body, well-development of ties and muscles, proportional head with wide jowls, straight profile and long poll, expressed eyes, long, high or moderate standing, straight neck, moderate long and moderate high withers, long and moderate slope shoulders, long loin, moderate long to long, optimal shaped, oval croup, wide or moderate, deep chest, round-shaped ribs, moderate wide croup, correct position and toeing-out of forelimbs and hind limbs, moderate to long, well-muscled forelegs, well-developed knees, canons and hock joints, normally developed fetlock joints, well-muscled gaskins, a trend to put legs narrow both for forelimbs and hind limbs and swing outwards, several horses had a long and concave back and a backward deviation of the carpus.
Sprinters	4	Wide jowls, expressed eyes, moderate slope shoulders, straight loin, wide and deep chest, base-narrow position of forelimbs, toeing-out of forelimbs and hind limbs, well-developed canons, small hooves.
Sultans	9	Moderate developed ties, moderate long neck, moderate long poll, moderate high withers, moderate long and optimal shaped croup, moderate chest and croup, correct position and toeing-out, well-muscled moderate forearm, moderate developed knees, good canons and fetlock joints, moderate long and in some cases sloping pasterns of forelimbs, good flexor tendons, firm hooves, moderate developed hock joints, several horses had standup shoulders and concave back and base-narrow position of forelimbs and hind limbs, long, sloping pasterns of hind legs and low heel.

The earlier authors noticed that horses of Spekonis sire line had a long neck more often than the representatives of the other historical sire lines. In 1985, 20.0 % of horses from Spekonis sire line had good withers, 42.8 % – good, long croup, 20 % – long, sloped shoulders, but only 5.7 % of them had concave back and 8.6 % – toeing-out. Such conformation fault as sloping pasterns that is typical nowadays was not found at all in 1985. The earlier authors reported that 12.3 % of mares of Spekonis sire line had base-narrow position of forelimbs. The evaluation results in 1985 showed that Spekonis line had the best quality in the breed in the group of stallions older than 3 years [9]. This kind of comparison had not been carried out nowadays yet, because actual sires were of various origins. It is also not easy to compare stallions by the quality of progeny, mainly because the selection of horses is difficult due to large number of horse owners and less data from all young horses. Furthermore, some stallions had a small number of progeny and were not used for breeding purpose, too intensive by.

CONCLUSIONS

1. The comparison of Latvian Warmblood carriage type stallions of Spekonis sire line and their progeny by the quality of conformation showed that the stallions did not differ significantly.
2. Some differences in the conformation of the progeny was found by the description of conformation traits – in width of chest, shape of croup – for slope croup and oval croup, good development of hock joints and occurrence of long back and long neck ($P < 0.05$).
3. The progeny of stallion Sidrabs were more qualitative, although had such conformation faults as toeing-out and a trend to put legs narrow both for forelimbs and hind limbs and swing outwards.
4. Toeing-out was the most common conformation fault for all progeny from this line (occurrence of trait – 47.8 %), also long (26.1 %) and concave back (30.4 %).
5. The analysis of the origin of stallions showed that they came from three founder's sons, and it was recommended to maintain the division in three branches hereafter with the aim to preserve a diversity of breed's carriage type.
6. There was insufficient evaluation data of some stallions, licensed before 2010, without description of the traits defined as methodical of the recent breeding program. It was necessary to organize a repetitive evaluation of sires that would help to calculate heritability.

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ЭКСТЕРЬЕР ЖЕРЕБЦОВ И ИХ ПОТОМСТВА ГЕНЕАЛОГИЧЕСКОЙ ЛИНИИ СПЕКОНИСА УПРЯЖНОГО ТИПА ЛАТВИСКОЙ ПОРОДЫ

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РЕЗЮМЕ

Главная цель в разведение лошадей упряжного типа Латвийской породы – получить типичных чистопородных животных с минимальным влиянием современных спортивных пород. В наше время самая распространенная линия упряжного типа – линия Спекониса. Цель работы была сравнить качество экстерьера жеребцов и их потомства линии Спекониса упряжного типа Латвийской породы.

В исследование анализированы данные о 12 лицензированных жеребцов линии Спекониса. Использованы данные о экстерьерной оценке и описание экстерьерных качеств четырех жеребцов и их потомков.

Анализ происхождения жеребцов показал, что жеребцы являются представителями трех разных ветвей линий и в предыдущем рекомендуется сохранить разнообразие в генеалогии.

Исследование экстерьерных качеств потомства показала, что представителям линии характерна сухая конституция, гармоническое сложение, хорошо развитые связки, пропорциональная голова с прямым профилем, широкими ганахами и выразительными глазами, прямая шея средней длины, однако большая часть потомства имеет узкую постановку ног и размет пальцев.

Были установлены достоверные различие ($P < 0.05$) между потомков жеребцов в таких приметах, как длинная спина, длинный и широкий круп, широкая грудь, хорошее развитие бабок, где наилучшие результаты показали потомки жеребца Сидрабса, но кроме позитивных качеств у них встречаются и размет и неточности хода.

Ключевые слова: Латвийская порода лошадей, упряжной тип, жеребцы, линия Спекониса, экстерьер

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CHARACTERIZATION OF GENETIC HORSE BREEDING RESOURCES IN RUSSIA USING STR MARKERS

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ABSTRACT

The population genetic analyses were carried out on 17 microsatellite loci for 4439 horses of 15 breeds including Altai, Bashkir, Buryat, Khakasskaya, Mezenskaya, Pechorskaya, Tuvinskaya, Vyatka, Yakut, Zabaykalskaya, Shetland Pony, Akhal-Teke, Thoroughbred, Orlov Trotter and Russian Heavy Draught bred in Russia. The compared mean values of microsatellite variation were insignificantly higher in the inspected native breeds in comparison with most cultural breeds. Population diversity varied in the inspected breeds by A_e from 3.21 to 4.47, by H_o from 0.605 to 0.776. The high allele variability including 4 private alleles ASAB17D, CA425E, HMS2D and HMS2G was found in Bashkir horse. The studied populations differed in their genetic structure and degree of differentiation (Nei's genetic distances were in the interval 0.154–0.662). The analysis showed that the native breeds of horses from Eastern Europe and Asia form overall cluster. All native populations of horses revealed rather high resources of genetic variability permitting successful implementation of conservation programs.

Keywords: *genetic diversity, horse breeds, microsatellite DNA*

INTRODUCTION

One of the priority tasks of the international programs of FAO and EAAP is the conservation of animal genetic resources. Investigation and rational use of the gene pools of domestic studs and local breeds is of great importance due to good adaptation to local climatic conditions, resistance to diseases and universal qualities. Russia has a significant part of the world's resources of horse breeding. The Russian Federation State Registry of

selection achievements includes 44 horse breeds half of which are unique native populations. Russia has a long history of horse breeding, and various indigenous breeds had been developed in different geographical regions. The horse has always played an important role in the cultural historic traditions of people. In Russia there were created such well-known breeds as Orlov Trotter, Don, Budenny, Tersk, Russian Heavy Draught and some other during the last three centuries. In recent years the country succeeds in developing meat herd horse breeding. Traditionally, horse meat dishes are in great demand in many nationalities on the territory of the Russian Federation.

The genetic characterization of a population is a useful initial step in the breed conservation and may be beneficial for future breeding strategies and selection programs. Genetic markers designed for parentage verification were extensively used to assess the levels of genetic variation of different horse breeds and to determine phylogenetic relationships with other populations [2, 3, 5, 6, 10, 11].

In conservation genetics, one main objective is to preserve the genetic variability within a population, assuming there is a positive correlation between genetic variation and population viability that may result from inbreeding, gene drift and periodical migration of animals in different horse breeds [4, 7, 8, 9, 12].

The aim of this study was to conduct a comparative analysis of the genetic diversity and relationships of different Russian horse breeds using microsatellite markers and the data on other domestic horse populations.

MATERIALS AND METHODS

In the study hair root and blood samples were used from 4439 horses of 14 native and stud breeds, including Altai, Bashkir, Buryat, Khakasskaya, Mezenskaya, Pechorskaya, Tuvinskaya, Vyatka, Yakut, Zabaykalskaya, Shetland Pony, Akhal-Teke, Thoroughbred, Orlov Trotter and Russian Heavy Draught. The samples from the horses of native breeds from Siberia (Buryat, Khakasskaya, Tuvinskaya, Zabaykalskaya) were collected during the 2008–2009 expeditions on studying horse resources. DNA extraction was performed by standard procedure from both hair root samples and whole blood samples using “Extra Gene™ DNA Prep 200” and “Diatom™ DNA Prep 200” kits (Laboratory Isogene, Russia). PCR products of 17 panel microsatellite markers (AHT4, AHT5, ASB2, ASB17, ASB23, CA425, HMS1, HMS2, HMS3, HMS6, HMS7, HTG4, HTG6, HTG7, HTG10, LEX3 and VHL20) were amplified with the fluorescently labeled primers (StockMarks®, Applied Biosystems) and then analyzed on the automated DNA sequencer ABI 3130 at the Laboratory of Genetics of the All-Russian Research Institute for Horse Breeding.

Genetic diversity within the populations was evaluated by the total number of allele variants (N_a), effective number of allele (A_e), number of allele per loci (N_V), observed (H_o) and expected heterozygosity (H_e) and F_{is} coefficients calculated using GENEPOP 1.3. Genetic differentiation among breeds was characterized by estimating overall and F_{st} values using FSTAT [1].

RESULTS AND DISCUSSION

The number of alleles at each locus varied between 6 (HTG7) and 19 (ASB17) and on average amounted to 7.16 per locus. In addition to the standardized equine DNA typing allele nomenclature of 17 equine-specific STR loci [13], the presence of four additional alleles (ASAB17D, CA425E, HMS2D and HMS2G) was detected in local horse breeds. There were significant differences in the effective number of allele (A_e) and number of allele per loci (NV) among breeds (Table 1). Population diversity varied in inspected breeds by A_e from 3.21 to 4.47 and by NV from 5.29 to 8.44. The private alleles were registered only in some native breeds including Bashkir (4), Altai (2), Yakut (2) and Pechorskaya (1). Most of the private alleles were in very low frequencies and below 5 %. Only one private allele at locus ASB17 in the Altai horse from Ulagan was in high frequency (17 %).

The observed heterozygosity (H_o) values among the horse breeds ranged from 0.605 (Mezenskaya) to 0.776 (Tuvinskaya). Only 8 from 15 breeds were in Hardy-Weinberg equilibrium (HWE) and had negative F_{is} values for all loci. The reason of positive F_{is} values for Burayat, Vyatka, and Zabaikalskaya breeds may have been due to a small number of tested animals.

Breed	n	A_e	H_e	H_o	F_{is}	NV
Altai	39	4.466	0.744	0.723	-0.070	7.47
Bashkir	100	4.440	0.750	0.755	-0.006**	8.29
Burayat	13	3.213	0.656	0.610	0.061	7.47
Khakasskaya	15	4.045	0.726	0.723	-0.024	5.65
Mezenskaya	18	3.808	0.693	0.605	-0.112	5.53
Pechorskaya	12	4.253	0.738	0.718	-0.069	5.81
Shetland Pony	32	3.640	0.702	0.701	0.003	6.19
Tuvinskaya (Tuva)	30	4.204	0.748	0.776	0.013*	5.88
Vyatka	14	3.721	0.691	0.680	0.018	5.29
Yakut	42	4.270	0.732	0.734	-0.003*	7.00
Zabaikalskaya	31	4.013	0.729	0.765	0.019	5.82
Akhal-Teke	870	3.872	0.697	0.695	-0.004	7.65
Orlov Trotter	1244	3.741	0.706	0.692	0.020**	8.44
Russian Heavy Draught	34	3.759	0.670	0.679	0.029	6.50
Thoroughbred	1945	3.519	0.689	0.697	-0.012***	6.88

A_e – effective number of alleles; H_e – expected heterozygosity; H_o – observed heterozygosity F_{is} – population inbreeding level; NV – average amount alleles per locus.
Significant levels: * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

The compared mean values of microsatellite variation were insignificantly higher for the inspected native breeds than for the cultural breeds. The high values of genetic diversity (Ae, NV and Ho) including the number of private alleles were found in Altai, Bashkir and Tuvinskaya horses. Among stud breeds, Orlov Trotters had the highest allele variations (NV = 8.44) and total level of observed heterozygosity (Ho = 0.706). Obviously a high level of genetic diversity in the Orlov Trotter breed is explained by the fact that it carries the blood of many European horse breeds.

The studied populations differed in their genetic structure and degree of differentiation. Nei's genetic distances were in the interval of 0.154–0.662. Figure 1 shows the genetic relationship among horse breeds from restricted maximum likelihood analysis of the gene frequency data at 17 microsatellite loci. The analysis showed that the Russian native horse breeds from Eastern Europe and Asia form an overall cluster with Orlov Trotter and Russian Heavy Draught breeds.

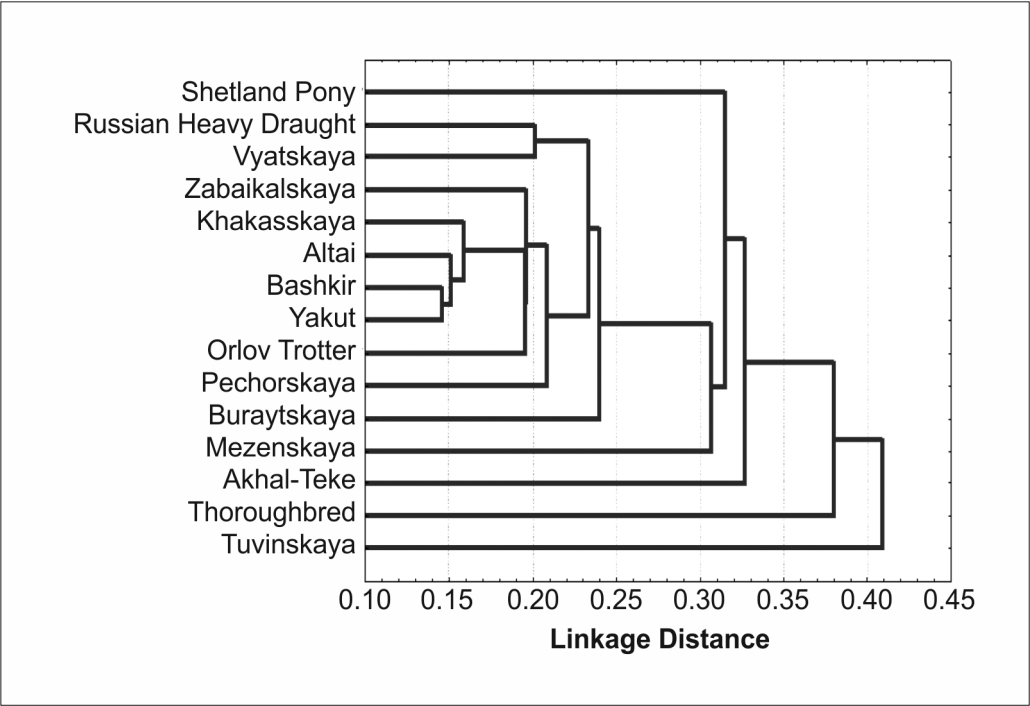


Fig. 1. **Dendrogram of genetic distances between Russian horse breeds**

Our dendrogram supports the view of Van de Goor et al. [14] that the phylogenetic microsatellite analysis reveals three clusters of related breeds: (i) the cold-blooded draught breeds, (ii) the pony breeds and (iii) the Warmblood riding breeds (in our case Akhal-Teke and Thoroughbred) together with the hot-blooded Standardbred. Orlov Trotters and to a lesser extent Russian Heavy Draft horses were used to improve many native

breeds for a long time, which of course had an impact on the genetic structure of local populations. It is interesting that Shetland Pony and Tuvinskaya horses, which both were in comparative isolation for many centuries, formed separate branches and significantly distanced from all the other breeds.

CONCLUSION

Microsatellite markers are more likely to detect small differences between populations than other methods due to their high levels of allelic variation, being able to discriminate in both mean number of alleles and overall heterozygosity. Our study demonstrates genetic differences between stud and native horse breeds that are bred in Russia. The studied populations differed in their genetic structure and degree of differentiation. The analysis showed that the native breeds of horses from Eastern Europe and Asia form an overall cluster. All native populations of horses revealed rather high resources of genetic variability permitting successful implementation of conservation programs. However, past experience in other countries showed that horse breeds used for meat production can undergo major declines in population number very rapidly. It is important to be concerned about the genetic diversity of native horse breeds on the basis of effective management, especially in respect to small populations.

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ХАРАКТЕРИСТИКА ГЕНЕТИЧЕСКИХ РЕСУРСОВ КОНЕВОДСТВА РОССИИ С ИСПОЛЬЗОВАНИЕМ STR МАРКЕРОВ

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РЕЗЮМЕ

С использованием 17 микросателлитных локусов был проведен популяционно-генетический анализ 4439 лошадей 15 пород, разводимых в России, включая алтайскую, башкирскую, бурятскую, хакасскую, мезенскую, печорскую, тувинскую, вятскую, якутскую, забайкальскую, шетлендского пони, ахалтекинскую, чистокровную верховую, орловскую рысистую и русскую тяжеловозную. Сравнимые средние значения микросателлитной изменчивости были незначительно выше у изученных аборигенных пород, чем у более культурных пород лошадей. Популяционное разнообразие у изученных пород варьировало по показателям A_c от 3,21 до 4,47, H_o от 0,605 к 0,776. Высокая степень полиморфности при наличии 4 частных аллелей ASAB17D, CA425E, HMS2D и HMS2G была выявлена у башкирской лошади. Изучаемые популяции различались по своей генетической структуре и степени дифференциации, генетические расстояния по Nei находились в интервале 0,154–0,662. Анализ показал, что местные породы лошадей из Восточной Европы и Азии в целом формируют общий кластер. Все местные популяции лошадей имели достаточно высокие ресурсы генетической изменчивости, позволяющей успешно реализовывать программы по их сохранению.

Ключевые слова: генетическое разнообразие, породы лошадей, микросателлиты ДНК

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THE CURRENT STATE OF ANIMAL GENETIC RESOURCES IN SLOVAKIA

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ABSTRACT

Despite the lower production and abilities to compete with high-productive breeds, local breeds are still important for countries as their heritage. The cultural and environmental roles of these breeds have to be taken into account and proper efforts have to be put on their conservation and sustainable utilization. The aim of this study was to describe current state, activities, support and state of endangered animal genetic resources in the Slovak Republic. The study was performed based on data from national database for animal genetic resources and measures supported via Rural Development Programme. There were 14 breeds eligible for the support via Rural Development Programme. Despite of this support some populations decreased in size. No poultry farmers requested for this support. The study showed that in Slovakia the passion for the certain breed is very important for its conservation and the legal base is needed for ensuring the long-term maintaining of the endangered breeds.

Keywords: *animal genetic resources, monitoring, conservation, local breed*

INTRODUCTION

It is generally recognized that the local breeds are the source of genes for improving the health and performance traits for mainstream breeds and are well adapted to a specific environment [9]. The local breeds keep their historical value, they are important in production of local animal products and help in supporting the employment in the marginal regions. Despite these facts local breeds have to face the drop of the population size. The main factor of rapid erosion of farm animal diversity is lack of economic profitability of local breeds [4]. There was significant drop of numbers of all species in region of Central and Eastern Europe during transformation period (1989–2002) reported by several authors [2, 6, 8, 12]. On the other hand, there is a trend of increasing population

size of exotic breeds in the Slovak republic. Although not so competitive in production field, the cultural and environmental values of local breeds have to be recognized and supported. According to Global Plan of Action for Animal Genetic Resources the efforts to conserve and sustainably use the animal genetic resources were grouped into several strategic priority areas. These include characterization, inventory and monitoring of trends and associated risks, sustainable use and development, conservation, and policies, institutions and capacity-building [3].

The aim of the study was to describe and evaluate the current state of animal genetic resources in Slovakia. The emphasis was given to monitoring, conservation measures and support of *in situ* conservation of animal genetic resources.

MATERIALS AND METHODS

In the study data from national database (EFABIS) and measures supported via Rural Development Programme were used to describe the state of animal genetic resources and their conservation and sustainable use.

The monitoring of animal genetic resources is performed via cooperation with Breeding Services of the Slovak Republic, s. e. and authorized breeders' organizations of respective breeds. The population data of 104 breeds was updated for year 2013. Detailed numbers are presented in Table 1. There are 14 other breeds monitored in Slovakia. However, these are not registered in the database as these are mainly recently imported exotic breeds reared mostly on one farm.

Since 2007 Slovakia has provided the support for the conservation of genetic resources in agriculture via Rural Development Programme (2007–2013) in accordance with Council Regulation (EC) No. 1698/2005 and Commission Regulation (EC) No. 1974/2006.

Table 1. The list of updated population data by the species			
Species	Breeds together	Updated for year 2013	Not updated/ Extinct
Cattle	14	11	3
Goose	4	3	1
Duck	3	2	1
Goat	3	2	1
Rabbit	43	41	2
Chicken	30	16	14
Horse	11	11	0
Turkey	1	0	1
Sheep	12	12	0
Pig	10	6	4
Japanese quail	4	0	4

RESULTS AND DISCUSSION

The state administration promotes the conservation of the biological diversity of farm animals by passing and sticking to legislative measures the most important of which is Act No. 194 of 1998 on Farm animal breeding. This act specifies the rights and duties of authorized organizations and certified breeders' associations to carry out their professional activities connected with animal breeding [5]. This act also defines the "protected farms", however this paragraph lost its power after Slovakia entered European Union. These are defined as farms keeping animals of endangered breeds that are used for conservation of breed gene pool and maintenance of its historical value [1].

At the present the legislation is insufficient and the long-term program for protection and sustainable use of animal genetic resources has to be adopted. There is still lack of funding and capacities to ensure the appropriate long-term conservation of the most endangered and valuable animal genetic resources.

Slovakia was the member of EFABIS (European Farm Animal Biodiversity Information System) project financed by EU (2002–2005) with aim to create a net of databases enabling regular and automated synchronization of data among the single national nodes. In the present the Slovak EFABIS node is updated on yearly base. National EFABIS node is hosted and managed by Research Institute for Animal Production Nitra.

The most of animal genetic resources conservation is realized via rearing of animals on the farms (*in situ*). The support via Rural Development Programme (RDP) is provided as the compensation of income loss due to lower production [10]. The list of breeds eligible for the support is summarized in Table 2. In the recent study [11] authors compared the numbers of purebred animals of supported breeds. The results are not clear as the number of animals decreased in some breeds and increased in others. However, support plays a role in preventing the breeds of becoming extinct.

Table 2. Species and breeds supported via RDP 2007–2013	
Species	Breed
Cattle	Slovak Pinzgau
Sheep	Valachian (original type)
Goat	White Shorthaired
Horse	Slovak Warmblood, Hutsul, Furioso, Nonius, Slovak Sport Pony, Lipitsa, Shagya Arab, Noric of Murany
Chicken	Oravka, Plymouth Rock, Rhode Island Red, New Hampshire, Vlaška, Sussex
Goose	Slovak White, Suchovy

Beside *in situ* conservation, there are *ex situ in vivo* and *ex situ in vitro* conservation efforts aimed on maintaining breeding animals and sperm of endangered local breeds.

The local breeds including original type of Valachian sheep, Oravka chicken Zoborsky and Nitriansky rabbit, Mangalica pig and Japanese quail are maintained in *ex situ in*

vivo conditions at Research Institute for Animal Production Nitra. Slovak University of Agriculture in Nitra is active in *ex situ* conservation of Oravka chicken.

The efforts for *ex situ in vitro* conservation exist in Slovakia though not organized. Insemination centers and National Stud keep the samples, mainly the sperm for the commercial use. Since 2009 Research Institute for Animal Production Nitra hosts and manages the database CRYOWeb with aim to register the samples of endangered breeds of farm animals available for long-term conservation. In the present there are samples kept and registered at RIAP Nitra and partner insemination center.

Cattle. There were 11 breeds of cattle updated in 2013 in the database. These included 3 multipurpose breeds, one dairy and 7 beef breeds. The most typical breeds are dual-purpose Slovak Simmental and Slovak Pinzgau. While the Slovak Simmental breed represents the biggest part of the cattle, the Pinzgau breed is considered at risk. This is not due to population size, but due to high level of inbreeding. The Slovak Pinzgau breed is supported by the Rural Development Programme (RDP) as it is considered endangered on the European level. Although the population size of Slovak Pinzgau breed is stabile, the number of purebred animals is low and decreasing. The number of herds is also decreasing and farmers use the crossing with beef breeds [7] to turn their herds to beef production and extensive farming. In the last years the population of beef breeds has increased rapidly and several exotic breeds were imported like Gasconne, Salers, Chianina.

Sheep. In 2013 there were 20 breeds of sheep monitored. Some of the populations are so small and are represented only by one or two farmers and therefore only 12 of them are regularly updated in database. In sheep Valachian breed is supported via Rural Development Programme. Although the number of animals increased since support provided, farmers declare that the increase is mainly due to their enthusiasm for the breed and its tradition (Table 3).

Table 3. Number of registered purebred females of supported breeds			
Breed	2009	2011	2013
Pinzgau	1600	1763	1430
Valachian	30	102	225*
White Shorthaired	744	934	774
Slovak Warmblood	1857	1650	923
Hutsul	119	129	150
Furioso	267	156	172
Nonius	58	22	38
Slovak Sport Pony	177	92	75
Lipitsa	140	152	185
Shagya Arab	156	171	181
Noric of Murany	239	100	112
*year 2012			

There are proposals to include the Tsigai and Askanian Merino breed into the list of RDP supported breeds. Although the population size of Tsigai sheep is stable the Sheep Breeders' Association is warning that the number of purebred animals is decreasing. The similar situation is reported for the Improved Valachian breed.

Goat. The situation with goats is quite similar to sheep and cattle although the size of populations is smaller. There were five breeds monitored in 2013 from which two were updated in database. The exotic breeds of goats were imported during the last few years but these are mainly reared as hobby animals or tourist attractions. The White shorthaired goat was supported via RDP and recently there is proposal to support also the Brown Shorthaired goat.

Pigs. There were six breeds monitored in 2013. The sizes of pig populations are stable or decreasing in Slovakia and so are the numbers of purebred animals. This is mainly due to intensive crossbreeding and use of hybrids. The production of breeding animals is also decreasing. There was no pig breed supported via RDP.

Horses. The situation with horses is quite different compared with the previous species. In 2013 there were 11 breeds monitored. The populations of horses are rather small and slightly changing in time. Most of breeds are classified as endangered and are supported via RDP and it is planned to support them also in the future. As the size population of horses is small, there are some efforts of breeders' associations in storing the frozen semen for future use.

Poultry and rabbits. The situation in poultry breeding is the most alarming. There were 17 breeds of chicken, 3 breeds of geese and 2 breeds of ducks monitored and updated in 2013. The support for several breeds of poultry was provided in the period of 2007–2013. Despite the support, no farmer submitted a request for subsidies. The rearing of purebred poultry is mainly performed by small farmers, who keep their flocks not just for production reasons.

Table 4. Number of poultry purebred females in registered farms of Slovak association of breeders			
Breed / Species	2009	2011	2013
Oravka / chicken	485	295	350
Slovak White / goose	56	29	34
Suchovy / goose	85	25	55

Although the rabbit sector is on the edge of interest, there were 43 breeds monitored in 2013. The situation is similar to poultry where farmers keep their animals mainly as their hobby. There are 10 rabbit breeds that were created by Slovak farmers and enthusiasts.

CONCLUSION

Although there is missing legal frame and lack of funding, some measures for animal genetic resources protection have been applied in Slovak republic. The passion for domestic breeds of poultry and rabbits helps preventing these breeds from becoming extinct. The most important step in protecting the animal genetic resources is adopting the legislative that will organize the efforts of all stakeholders and ensure funding for the conservation of most endangered breeds.

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THE EFFECT OF AGE AT FIRST CALVING ON PRODUCTIVITY AND LONGEVITY OF LATVIAN BROWN AND LATVIAN BLUE COW GENETIC RESOURCES

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ABSTRACT

The aim of the study was to determine how age at first calving affects the lifetime milk productivity and longevity in Latvian Brown and Latvian Blue cow genetic resources. The data was obtained from Agricultural Data Centre and for the research the data was collected about the age at first calving, milk productivity and life length. The study indicated that in Latvian Brown cow genetic resources lifetime productivity was higher in the group of cows with first calving age under 24 months (13909.5 kg energy corrected milk (ECM)). The same situation was recorded in Latvian Blue cow breed (15905.2 kg ECM). The longest lifespan was found in the Latvian Blue cow breed, in the group where cows first time calved before the age of 24 months (2330 days). Life length in the Latvian Brown cow breed was significantly higher in the first calving age group under 27 months (2068–2080 days).

Keywords: *genetic resources, age at first calving, milk productivity, longevity*

INTRODUCTION

Latvia has two local dairy cow breeds: Latvian Brown and Latvian Blue. Latvian Brown genetic resources include cattle with at least 60 % Latvian Brown breed blood provided that the rest 40 % are Danish Red or German Red (Angler) cow blood. The productivity in higher lactation should not be lower than 4000 kg and the milk protein content should not be lower than the breed's average. Latvian Blue cattle are ascribed to animal genetic resources – if they have more than 50 % Latvian Blue blood and at least breed's average milk productivity and milk protein content. Latvian Brown and Latvian Blue cow breeds are characterized by decent longevity, but the level of productivity in these

cow breeds is not very high. The average life length of Latvian Brown and Latvian Blue cow in 2012 was 4.29 lactations in comparison with local Holstein Black and White cows – 3.50 lactations. In general, longevity as a trait is mainly affected by different factors including cow health, reproductive traits, breed, breeding conditions, productivity and others.

The average life length of Latvian Brown cows was 3.49 lactations, but of Latvian Blue cows it was 3.66 lactations. The reason behind that difference might be the aim of animal breeding, because Latvian blue cows are not in general used for production purposes, but mainly for tourism and hobby breeding purposes.

The aim of the study was to determine how age at first calving affects the lifetime productivity and longevity of Latvian Brown and Latvian Blue cows preserved as part of national genetic resources.

MATERIALS AND METHODS

In the study the data was analysed on 288 Latvian Brown and 74 Latvian Blue cows that had started at least the first lactation and were culled from the herd in the period from 2000 to 2013. Latvian Brown and Latvian Blue cows were adequate regarding the genetic resource requirements for each breed.

The data used in this study was obtained from Latvian Agricultural Data Centre. The information about the cow productivity, the date of cows' birth, the date of first calving and the date of culling was obtained from the data base. The above mentioned traits were used to calculate the cows' lifespan, lifetime productivity, and daily productivity.

To characterize milk productivity, energy corrected milk (ECM), was calculated by the following formula [8]:

$$\text{ECM} = \text{milk yield} \times \frac{[(0.383 \times \text{fat, \%}) + (0.242 \times \text{protein, \%})]}{3.14}$$

The data in Tables are represented as mean $\pm$ standard error. The factor of farm impact on cow longevity and productivity traits was determined by the analysis of variance. Pairwise comparisons between different first calving ages and between different cow breeds were carried out using Bonferroni test.

The mathematical processing was performed using the SPSS program package.

RESULTS AND DISCUSSION

In our study the average age at first calving is 27.9 months, whereas the average first calving age of Irish dairy cows is 25.8 months [4], Italian Holsteins 28.1 months [9], Swedish dairy cows 28.4 months [5] and Chinese Holstein dairy cows 29.3 months [10]. The literature indicates that the highest lifetime productivity was determined for cows

that first calved at the age of 24–28 months [7, 10]. This age gives highest productivity levels in the first lactation, and in all productive life. The considerable variation in calving age observed both within and between farms may be attributed to differences in age at first breeding as a result of farm management and/or poor growth rate, or it may be primarily related to heifer fertility.

The highest productivity in the lifespan was recorded for Latvian Blue cows, that first calved before the age of 24 months (15905.2 kg energy corrected milk (ECM)), but the lowest productivity was recorded for Latvian Blue cows that first calved over 30 months of age (9036.8 kg ECM) (Table 1).

Table 1. The correlation between life time productivity and age at first calving for Latvian Brown and Latvian Blue cows						
Breed	Age at first calving, month	Number of cows	$\bar{x} \pm s_{\bar{x}}$	Min	Max	V, %
Latvian Brown	<24	60	13909.5 $\pm$ 1105.91 ^A	4769	39944	67
	24–27	88	12873.3 $\pm$ 913.18 ^{AB}	4069	31949	64
	28–30	74	13100.2 $\pm$ 995.82 ^{AB}	4670	35670	65
	>30	66	11969.7 $\pm$ 1054.45 ^B	4010	39532	47
Latvian Brown	<24	18	15905.2 $\pm$ 1644.41 ^A	4032	30397	47
	24–27	22	12926.1 $\pm$ 1487.42 ^{AB}	3874	28585	54
	28–30	17	12854.2 $\pm$ 1692.10 ^{AB}	4048	21150	56
	>30	17	9036.8 $\pm$ 1692.10 ^B	4151	20524	64
^{AB} – traits with different superscriptions are significantly differ at level 0.05						

The average milk yield of Latvian Brown cows was significantly higher (13909.5 kg ECM) for cows that first calved younger than 24 months, but it was significantly lower (11969.7 kg ECM) for cows which first calved older than 30 months. When the age of first calving was 24–27 and 28–30 months no significant differences were found, but the average lifetime productivity was slightly lower than that of cows that firstly calved younger than 24 months.

Latvian Brown and Latvian Blue cow breeds are known for their potential on high longevity, and they are characterized as undemanding for life conditions and great resistance to other environment factors. The highest lifetime productivity was reached within the groups of cows which first calved at the age of 21, 22 and 24 months (more than 17000 kg ECM per lifetime), and the lowest at the age of 30 months and over (lifetime productivity was lower than 10000 kg ECM). In Smolensk there was a study on the population of Holstein cows that showed the optimal first calving age of 27–30 months. In this calving group larger milk productivity and milk yield in the first lactation was found [13]. Significantly longer life was determined in the Latvian Blue cow breed in the group with the first calving age less than 24 months (2330 days), but the shortest life was

recorded in the Latvian Brown cow breed when the age at first calving was <27 months (2068–2080 days) (Table 2).

Breed	Age at first calving, month	Number of cows	$\bar{x} \pm s_{\bar{x}}$	Min	Max	V, %
Latvian Brown	<24	60	2068 $\pm$ 110.9 ^A	720	3960	43
	24–27	88	2080 $\pm$ 84.8 ^A	810	3690	40
	28–30	74	2132 $\pm$ 87.4 ^{AB}	990	3840	35
	>30	66	2227 $\pm$ 91.6 ^B	960	4170	33
Latvian Blue	<24	18	2330 $\pm$ 163.8 ^A	810	3450	30
	24–27	22	2102 $\pm$ 122.7 ^B	1140	3090	27
	28–30	17	2133 $\pm$ 180.2 ^B	960	3390	35
	>30	17	2255 $\pm$ 192.4 ^{AB}	1140	4200	35

^{AB} – traits with different superscriptions are significantly differ at level 0.05

Latvian Brown cows that first calved older than 30 months had significantly longer life, but in the Latvian Blue breed the situation was diametrically opposite – the cows that first calved at the age under 24 months had significantly longer life. The literature survey shows that lifespan is longer for cows that first calve at the age of 23 months or earlier [1, 3].

Daily productivity is one of the main farm economy indicators. Different studies have shown that the costs of raising one heifer – future cow – are at least 3 times higher than the profit that comes from one slaughtered cow [2, 14]. The average daily milk productivity is shown in Table 3.

Breed	Age at first calving, month	Number of cows	$\bar{x} \pm s_{\bar{x}}$	Min	Max	V, %
Latvian Brown	<24	60	6.0 $\pm$ 0.30 ^A	4.5	10.7	42
	24–27	88	5.6 $\pm$ 0.23 ^A	4.4	11.5	45
	28–30	74	5.5 $\pm$ 0.26 ^{AB}	4.3	10.5	67
	>30	66	4.8 $\pm$ 0.27 ^B	3.9	10.8	53
Latvian Blue	<24	18	6.5 $\pm$ 0.49 ^A	5.3	9.2	47
	24–27	22	5.8 $\pm$ 0.44 ^A	4.3	9.6	54
	28–30	17	5.5 $\pm$ 0.46 ^A	3.5	8.2	35
	>30	17	3.8 $\pm$ 0.46 ^B	2.7	7.77	27

^{AB} – traits with different superscriptions are significantly differ at level 0.05

Daily productivity (6.5 kg ECM) was highest in the cow group that first calved younger than 24 months old, and the lowest productivity was in the cow group with the first calving age over 30 months (3.8 kg ECM). Both breeds – Latvian Brown and Latvian Blue – show the same tendency, mainly because of lower lifetime productivity and longer life of cows in that group.

Literature survey indicated that the optimal age at first calving for dairy cows is 24–27 months, and in this group there are most stable results regarding every previously viewed characteristics [2, 3].

CONCLUSIONS

1. The highest lifespan productivity was recorded in Latvian Blue cows that first calved before the age of 24 months (15905.2 kg ECM), and the lowest productivity was recorded in Latvian Blue cows that first calved older than 30 months (9036.8 kg ECM).
2. The highest lifetime productivity was reached within groups of cows which first calved at the age of 21, 22 and 24 months (more than 17000 kg ECM per lifetime), and the lowest – at the age of 30 months and over (lifetime productivity was lower than 10000 kg ECM).
3. The highest daily productivity (6.5 kg ECM) was recorded in the group of cows that first calved younger than 24 months old, whereas the lowest productivity was in the cow group with the first calving age over 30 months (3.8 kg ECM).

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ВЛИЯНИЕ ВОЗРАСТА ПЕРВОГО ОТЕЛА НА ПОЖИЗНЕННУЮ ПРОДУКТИВНОСТЬ И ДОЛГОЛЕТИЕ ГЕНЕТИЧЕСКИХ РЕСУРСОВ ЛАТВИЙСКОЙ БУРОЙ И ЛАТВИЙСКОЙ ГОЛУБОЙ КОРОВ

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РЕЗЮМЕ

Цель работы была определить, как возраст первого отела влияет на пожизненную продуктивность и долголетие генетических ресурсов Латвийской бурой и Латвийской голубой коров.

В исследование использованы данные Сельскохозяйственного центра о генетических ресурсах Латвийской бурой и Латвийской голубой коров. В работе представлены данные о возрасте первого отела, долголетие и молочной продуктивности. В ходе работы выявлено, что наибольшая пожизненная продуктивность Латвийских бурых коров была в группе тех коров, которые в первый раз отелились в возрасте до 24 месяцев (13909.5 кг). В группе Латвийских голубых коров наблюдается такая же ситуация (15905.2 кг). Наибольшая продолжительность жизни была у коров породы Латвийская голубая, которые в первый раз отелились в возрасте до 24 месяцев (2330 дней), но наименьшая продолжительность жизни была у коров породы Латвийская бурая, которые в первый раз отелились в возрасте до 27 месяцев (2068–2080 дней).

Ключевые слова: возраст первого отёла, молочная пожизненная продуктивность, долголетие

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POLYMORPHISM OF INSULIN-LIKE GROWTH FACTOR (IGF-1) GENE AND ITS INFLUENCE ON CATTLE GROWTH RATE

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ABSTRACT

The insulin-like growth factor (IGF-1) is associated with several economically important traits, namely with growth and development of animals. The aim of this study was to investigate the insulin growth factor gene polymorphism and to determine its effect on the growth rate of cattle. IGF-1 gene polymorphism was analyzed using PCR-RLFP method using Sna BI restriction enzyme. Insulin like growth factor (IGF-1) gene A allele occurred with 0.471 rate, and B allele – 0.529 rate. A allele at a highest rate (0.708) was found in the Lithuanian Black and White breed, and B allele (0.711) in the Limousine breed. The breeds were grouped in beef and dairy cattle breeds. It was found, that IGF-1 A gene allele frequency varied from 0.368 in beef cattle breeds to 0.676 in dairy cattle breeds. Meanwhile, the B allele frequency varied from 0.324 dairy cattle breeds to 0.632 beef cattle breed. The cattle IGF-1 gene AA genotype occurred with 0.235 frequency, AB genotype – 0.471 frequency and BB genotype – 0.294 frequency. AA genotype with the highest frequency (0.500) was found in the Lithuanian Black and White breed, AB – in the Charolais breed (0.533) and BB – in the Limousine breed (0.474). It was established that the beef cattle with IGF-1 gene BB genotype had the largest weight gain in all feeding period (122.7 g, $P < 0.05$) compared with milk cattle breeds.

Keywords: *insulin-like growth factor (IGF-1), polymorphism, cattle*

INTRODUCTION

In recent years, the interest in cattle selection, based on genetic technologies has significantly increased. It is important to adjust properly the achievements in selection and genetics, when the market dictates basic requirements for the intensive farming conditions. Molecular genetic techniques permit to evaluate animals and use to a full extent useful economic traits. Through these techniques we can identify genes, affecting livestock productivity. It is known that productivity of livestock and economic traits, such as growth rate of the animal, amount of meat and milk and other properties are determinate by genes. One of the most important genes, affecting cattle productivity traits is insulin-like growth factor 1 gene. It was found, that IGF-1 gene encodes a growth factor that is associated with body weight growth of the animal [3]. Equally, IGF-1 gene is influencing development of muscle. It also promotes consumption and protein synthesis of amino acids in muscle and other tissues [1]. Two polymorphic IGF-1 sites were analyzed considering productivity traits of beef cattle. The study of Hereford cattle indicated, that microsatellites polymorphism of the promoter region of IGF-1 gene is associated with the body weight at birth and weaning, as well as the growth rate [7]. According to Ge and other researchers [4] this type of polymorphism was not found in the Angus cattle breed. According to Li et al., [6] cattle with IGF-1 gene BB genotype had higher weight at weaning. BB genotype was also established as superior, because bulls with BB genotype had higher growth rate [2].

The aim of this study was to investigate the insulin-like growth factor gene polymorphism and to determine its effect on the growth rate of cattle.

MATERIAL AND METHODS

Fifty one cattle were genotyped belonging to the Lithuanian Black and White (LBW), Lithuanian Red (LR), Limousin (Li), Charolais (Ca) cattle breeds. The data of productivity (weight gain averages in different quarters) of cattle were obtained from UAB „Šilutės veislininkystė“. Investigated bulls were grown from 210 days to 500 days of age. The bulls were weighed in every four quarters. Genotyping was done in Lithuanian University of Health Sciences, K. Janušauskas Laboratory of Animal Genetics. Hair root samples (10–20 pc.) were taken into plastic bags with references. DNA was extracted from hair roots using a phenol-chloroform method. PCR reactions were performed using Applied Biosystems 2700 Thermal Cycler. IGF-1 gene was analyzed using PCR-RLFP method, with primers of the IGF-1 gene [4], direct 5'–ATTACAAAGCTGCCTGCCCC–3' and reverse 5'–ACCTTACCCGTATGAAAGGAATATACGT–3' oligonucleotide primers (10 pmol) 0,2 mM dNTP, 50 mM MgCl₂, 10 × Taq Buffer (NH₄) SO₄, 1 U Taq DNA polymerase, BSA (20 mg/ml) ("Fermentas"). The polymerase chain reaction (PCR) was done under the following conditions: 95°C for 3 min, 94°C for 45 s, 62°C for 45 s,

and 72°C for 45 s with a final extension at 72°C for 5 min. The reaction is carried out by 35 cycles [7]. After amplification, PCR product was digested with *Eco 105I* (*Sna BI*) restriction enzyme. After PCR 249 bp fragment was obtained. After digestion with restriction enzymes, we got A allele – 223 bp, 26 bp, and B allele – 249 bp. The genotyping was done in 3 % agarose gel stained with ethidium bromide and photographed under UV light using „MiniBisPro“ video documentation instrument (Herolab).

The statistical analysis was performed on the statistical package R 2.12.2 and Excel spreadsheet 2010. We calculated the detection of IGF genes genotypes frequencies in different cattle breeds. Heterozygosity assessment calculated the classical χ^2 criterion. Unbiased estimator of variance was used for analysis breed and genotypes to evaluate the influence. The comparative group of averages difference to evaluate significance was counted Student's test. Differences were considered statistically significant at $p < 0.05$.

RESULTS AND DISCUSSION

Bovine IGF-1 gene allele and genotype frequencies were calculated in each tested cattle breed. The insulin-like growth factor gene of two alleles (A and B) was found in all tested breeds. IGF-1 gene A allele frequency varied from 0.289 in the Limousine breed to 0.708 in the Lithuanian Black and White breed, and B allele – from 0.292 in the Lithuanian Black and White breed to 0.711 in the Limousine breed. In all studied cattle breeds, A allele frequency was found 0.471 and B allele 0.529 frequency (Table 1).

Table 1. IGF-1 gene allele frequencies in four cattle breeds			
Breed	n	Allele	
		A	B
Limousin	19	0.289	0.711
Lithuanian Black and White	12	0.708	0.292
Lithuanian Red	5	0.600	0.400
Charolais	15	0.467	0.533
Total:	51	0.471	0.529

The breeds were grouped as beef and dairy cattle breeds. It was found, that IGF-1 A gene allele frequency varied from 0.368 in beef cattle breeds to 0.676 in dairy cattle breeds. Meanwhile, the B allele frequency varied from 0.324 dairy cattle breeds to 0.632 beef cattle breeds (Table 2).

Table 2. IGF-1 gene allele frequencies of beef and dairy cattle breeds		
Breeds	Alleles	
	A	B
Li + Ca (beef)	0.368	0.632
LBW + LR (dairy)	0.676	0.324

Three different genotypes – AA, AB and BB have been identified of insulin-like growth factor (IGF-1) gene. IGF-1 of gene AA genotype had the lowest frequency and ranged from 0.053 in the Limousine cattle breed to 0.500 in the Lithuanian Black and White cattle breed. Meanwhile, the AB genotype occurred with highest frequency and ranged from 0.400 in the Lithuanian Red cattle breed to 0.533 in the Charolais cattle breed.

Insulin-like growth factor gene's BB genotype frequency varied from 0.083 in the Lithuanian Black and White cattle breed to 0.474 in the Limousine cattle breed. In the investigated group of cattle AA genotype frequency was found 0.235, AB genotype frequency 0.471 and BB genotype frequency 0.294 (Table 3).

Table 3. IGF-1 gene genotype frequencies of the studied cattle breeds			
Breed	Genotype		
	AA	AB	BB
Limousin	0.053	0.474	0.474
Lithuanian Black and White	0.500	0.417	0.083
Lithuanian Red	0.400	0.400	0.200
Charolais	0.200	0.533	0.267
Total:	0.235	0.471	0.294

Breeds grouped as the beef and dairy cattle breeds showed that AA genotype of IGF-1 gene ranged from 0.118 in the beef cattle breeds to 0.471 in the dairy cattle breeds. Meanwhile, the AB genotype with highest frequency from 0.412 occurred in the dairy cattle breeds to 0.500 in the beef cattle breeds. The lower BB genotype frequency occurred from 0.118 in the dairy cattle breeds to 0.382 in the beef cattle breeds (Table 4).

Table 4. IGF-1 gene of genotype frequencies of the beef and dairy cattle breeds			
Breeds	Genotype		
	AA	AB	BB
Limousin + Charolais (beef)	0.118	0.500	0.382
Lithuanian Black and White + Lithuanian Red (dairy)	0.471	0.412	0.118

Insulin-like growth factor gene polymorphism and its influence on cattle weight gain (Table 5) has been investigated. Cattle with AA genotype of IGF-1 gene had a higher daily gain per 2nd fattening quarter (1143.2 ± 42.40 g) compared with AB (1036.6 ± 64.27 g) genotype. Meanwhile, cattle of BB genotype had statistically significantly higher daily gain during the 1st fattening quarter (1418.1 ± 86.55 g, $P < 0.05$) the 3rd fattening quarter (769.3 ± 96.23 g, $P < 0.05$), 4th fattening quarter (503.0 ± 48.97 g, $P > 0.05$), and also the daily gain during the whole fattening period (865.9 ± 46.22 g, $P < 0.05$) (Table 5).

Table 5. Influence IGF-1 gene on cattle weight gain						
Geno-type	n	Weight gain in 1 quarter, g	Weight gain in 2 quarter, g	Weight gain in 3 quarter, g	Weight gain in 4 quarter, g	Weight gain during all period, g
AA	12	1133.8 ± 38.95^a	1143.2 ± 42.40	423.3 ± 68.18^a	437.4 ± 72.14	678.9 ± 39.64^a
AB	24	1397.8 ± 67.83^b	1036.6 ± 64.27	644.9 ± 80.60	495.1 ± 39.64	722.5 ± 35.52^a
BB	15	1418.1 ± 86.55^b	1051.4 ± 44.86	769.3 ± 96.23^b	503.0 ± 48.97	865.9 ± 46.22^b
^{a, b} – averages, different letters of the table column marked with different letters, differ statistically significantly from each other ($p < 0.05$).						

In order to highlight the IGF-1 gene influence on the cattle weight gain, multi factorial genetic analysis was performed: breed, genotype and combined factor: breed x genotypes and their impact on cattle weight gain. The breed had a statistically significant influence on the weight gain variation per 1, 2, and 4 quarter. The genotype statistically significant influenced the weight gain during all fattening period (Table 6).

Table 6. Influence the genetic factors to cattle weight gain					
Factors	Weight gain in 1 quarter, %	Weight gain in 2 quarter, %	Weight gain in 3 quarter, %	Weight gain in 4 quarter, %	Weight gain during all period, %
Breed	31.0***	16.0*	14.6	16.7*	12.9
Genotype	3.7	1.6	3.6	0.6	11.5*
Breed x Genotype	8.9	8.2	3.1	5.7	4.4

The breeds were grouped as to beef and dairy cattle. IGF-1 gene AA genotype beef breeds cattle are characterized by a higher daily gain per quarter 2 (1221.8 ± 68.11 g) compared with dairy cattle breeds (1103.9 ± 50.80 g). The beef cattle of AB genotype had a higher weight gain during the 1st quarter (1463.6 ± 89.35 g) compared with the dairy cattle breeds (1237.9 ± 52.47 g) genotype, also BB genotype beef cattle characterized by higher daily gain during the 1st quarter (1469.7 ± 91.29 g) compared with the dairy cattle breeds (1083.0 ± 83.00 g), although the data were not statistically significant. Meanwhile, BB genotype beef cattle were distinguished by the largest weight gain in

all the feeding period (882.2 ± 51.57 g, $P < 0.05$) compared with the dairy cattle breeds (759.5 ± 61.50 g) (Table 8).

Table 7. Comparison of IGF-1 gene influence on fattening traits in beef and dairy cattle breeds						
Fattening period	Li+ Ca (beef)			LBW + LR (dairy)		
	AA	AB	BB	AA	AB	BB
	4	17	13	8	7	2
Weight gain in 1 quarter, g	1096.8 ± 79.95	1463.6 ± 89.35	1469.7 ± 91.29	1152.3 ± 45.38	1237.9 ± 52.47	1083.0 ± 83.00
Weight gain in 2 quarter, g	1221.8 ± 68.11	993.00 ± 86.62	1059.4 ± 51.28	1103.9 ± 50.80	1142.4 ± 55.34	999.5 ± 55.50
Weight gain in 3 quarter, g	569.3 ± 161.02	674.8 ± 104.42	793.8 ± 108.34	350.3 ± 55.83	572.3 ± 116.25	610.5 ± 166.50
Weight gain in 4 quarter, g	305.0 ± 16.17^c	501.1 ± 50.38	520.6 ± 54.73	503.6 ± 101.65	480.6 ± 64.55	388.5 ± 55.50
Weight gain during all period, g	756.5 ± 43.71	742.2 ± 44.41^a	882.2 ± 51.57^b	640.1 ± 51.48	674.7 ± 57.23	759.5 ± 61.50
^{a, b} – different letters in table row marked averages, statistically significantly difference between each other ($p < 0.05$).						

In recent years, the interest in beef and dairy cattle selection based on genetic technologies has increased. Animals can be selected by identification of genetic markers, related to specific trait. Such quantitative traits, like the growth rate of the animal and others productivity traits are controlled by multiple loci in the chromosomes.

It was found that insulin-like growth factor (IGF-1) gene, located in the 5 chromosome, regulates the growth rate of cattle [10]. Our studies showed, that IGF-1 gene A allele occurred with 0.47 rate, and B allele – 0.53 rate. A allele at the highest rate (0.708) was found in the Lithuanian Black and White breed, and B allele (0.711) in the Limousine breed. Similar results were reported by other researchers, that B allele occurred with the highest frequency – 0.54, and A allele – 0.46 frequency [8], however, other researchers found that A and B allele frequencies were respectively 0.52 and 0.48 [10].

After estimation of IGF-1 gene genotype frequencies, we found three genotypes – AA, AB and BB. AB genotype was found with the highest – 0.47 frequency, while AA genotype – 0.24 and BB – 0.29 frequency. BB genotype was identified at the highest frequency (0.38) in the beef cattle breeds compared with the dairy cattle breeds (0.12). Our results correlate with the data published by other researchers. The scientists, found that AA genotype occurred with 0.29 frequency, BB genotype – 0.24 frequency and the highest frequency was of AB genotype (0.47) [10].

Cattle fattening trait data analysis indicated that cattle with IGF-1 gene BB genotype had a higher daily gain. According to our study, BB genotype with the highest frequency occurred in the Limousine cattle breed (0.474) and the lowest in the Lithuanian Black

and White cattle breed (0.083). AB genotype with the highest frequency occurred in the Charolaise cattle breed (0.533) and the lowest frequency – Lithuanian Red cattle breed (0.400). AA genotype with highest frequency occurred in the Lithuanian Black and White cattle breed (0.500) and lowest – in the Limousine cattle breed (0.053).

According to Li et al., [6], BB genotype of cattle IGF-1 gene characterizes higher weight at weaning. Curi et al., [2] found significant IGF-1 gene genotype dependence on body weight in genetically different age groups. In the study it was found that BB genotype was superior, because bulls with BB genotype had higher growth rate [2].

Our results showed statistically significant differences of fattening traits between the genotypes. The growth rate of cattle with BB genotype was higher (865.9 ± 46.22 g; $p < 0.05$), compared with AA (678.9 ± 39.64 g; $p < 0.05$) and AB (722.5 ± 35.52 g; $p < 0.05$) genotypes. Our results coincided with the studies of other researchers, where animals with BB genotype had a higher daily gain. Studies were carried out in Poland, finding correlation between IGF-1 gene polymorphism and cattle growth rate and milk yield features. It was found that the growth rate of cattle with BB genotype was higher, than that of AA and AB genotypes, whereas the milk yield indicators showed that AB genotype cows were estimated better than AA and BB genotype cows. Such conclusions were drawn because in AB genotype cows yielded higher fat and protein content milk [11].

Our research suggests that the most useful IGF-1 gene allele is B allele, because animals with B allele and BB genotype are characterized by a higher weight gain.

The purpose of agricultural livestock selection is to breed and raise animals that have high productivity and other useful characteristics, to reduce production costs and to produce quality agricultural products that satisfy the needs of consumers and meet quality requirements of market. The use of molecular genetics methods may speed up cattle selection process, improve the quality of beef, lower costs, and make our production competitive in foreign markets. Insulin-like growth factor (IGF-1) gene is an important genetic marker, because its physiological effects are directly related to the economic traits. Regarding biological functions, insulin-like growth factor (IGF-1) gene is a genetic marker for prognosis of bovine growth rate.

CONCLUSIONS

1. Two alleles: A and B were found in the examined of insulin-like growth factor (IGF-1) gene in cattle. A allele was found with highest frequency 0.708 in the Lithuanian Black and White and lowest frequency – 0.289 in the Limousine cattle breed. B allele, which increases cattle weight gain, was found with the highest frequency (0.711) in the Limousine cattle breed, and with the lowest frequency (0.292) – in Lithuanian Black and White.
2. In the investigated group of cattle, three genotypes – AA, AB and BB had IGF-1 gene. AA genotype was present in 24.0 % cattle, AB genotype – 47.0 % cattle, and BB genotype, which increased the bovine weight gain in 29.0 %.

3. The Limousin breed cattle had the largest amount of BB genotype 47 %.
4. BB genotype bovine had a significantly greater 187 g ($p < 0.05$) weight gain than AA genotype cattle.
5. The genotype influence 11.5 % ($p < 0.05$) in cattle weight gain rate variability.

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INSULINO AGIMO FAKTORIAUS GENO (IGF-1) POLIMORFIZMO ĮTAKA GALVIJŲ AUGIMO SPARTAI

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SANTRAUKA

Insulino augimo faktorius (IGF-1) yra susijęs su keliais ekonominiu požiūriu svarbiais ypatumais, būtent su galvijų augimu ir vystymusi. Šio darbo tikslas – ištirti insulino augimo faktoriaus geno polimorfizmą ir nustatyti jo įtaką galvijų augimo spartai. Insulino augimo faktoriaus geno polimorfizmas nustatytas PGR-RFIP metodu, naudojant *Sna BI* restrikcinį fermentą. Galvijų IGF-1 geno A alelis rastas 0,471 dažniu, o B alelis – 0,529 dažniu. A alelis didžiausiu dažniu (0,708) rastas Lietuvos juodmargių veislėje, o B alelis (0,711) – Limuzinų veislėje. Sugrupavus veisles į mėšinių ir pieninių galvijų veisles, nustatyta, kad IGF-1 geno A alelio dažnis kito nuo 0,368 mėšinių galvijų veislėse iki 0,676 pieninių galvijų veislėse. Tuo tarpu B alelio dažnis kito nuo 0,324 pieninių galvijų veislėse iki 0,632 mėšinių galvijų veislėse. Galvijų IGF-1 geno AA genotipas rastas 0,235 dažniu, AB genotipas – 0,471 dažniu, o BB genotipas – 0,294 dažniu. AA genotipas didžiausiu dažniu (0,500) rastas Lietuvos juodmargių veislėje, AB – Šarolė veislėje (0,533) ir BB – Limuzinų veislėje (0,474). Nustatyta, kad statistškai reikšmingai IGF-1 geno BB genotipo mėsiniai galvijai pasižymėjo didžiausiu priesvoriu $122.7 \text{ g } p < 0,05$ per visą penėjimosi laikotarpį lyginant su pieninių veislių galvijais.

Raktažodžiai: insulino augimo faktorius (IGF-1) genas, polimorfizmas, galvijai

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ПОЛИМОРФИЗМ ГЕНА ИНСУЛИНОПОДОБНОГО ФАКТОРА РОСТА (IGF-1) И ЕГО ВЛИЯНИЕ НА ТЕМП РОСТА КРУПНОГО РОГАТОГО СКОТА

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РЕЗЮМЕ

Инсулиноподобный фактор роста (IGF-1) связан с несколькими экономически важными показателями, в частности с ростом и развитием животных. Цель – исследовать полиморфизм IGF-1 гена и его влияния на темп роста крупного рогатого скота. Полиморфизм IGF-1 гена установлен при помощи ПЦР-ПДРФ метода с использованием *Sna BI* фермента рестрикции. Аллель А IGF-1 гена крупного рогатого скота был найден частотой 0,471, аллель В – частотой 0,529. Максимальная частота А аллеля (0,708), найдена у Литовской черно-пёстрой породы, а В аллеля – (0,711) у породы Лимузин. Частота распределена от 0,235 АА генотипа, 0,471 АВ генотипа и 0,294 ВВ генотипа. АА генотип самой высокой частоты (0,500) найден у Литовской черно-пёстрой породы, АВ – Шароле породы (0,533) и ВВ – породы Лимузин (0,474). Темп роста крупного рогатого скота с генотипом ВВ был выше по сравнению с генотипом АА и АВ.

Ключевые слова: инсулиноподобный фактор роста (IGF-1), полиморфизм, крупный рогатый скот

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USAGE OF MUSCLE THICKNESS MEASURED BY ULTRASOUND FOR ASSESSMENT OF MUSCLE DEVELOPMENT IN SLOVAK PINZGAU HEIFERS

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ABSTRACT

The Slovak Pinzgau cattle belong to the group of endangered breeds in the Slovak republic. The decreasing population of the breed is changing the orientation of production from milk to production of heavy weaners in suckler cow system. The experiment was set to measure the thickness of muscle on three important body parts (shoulder, back and rump) and to study the relationships between muscle development and muscle thickness measured by ultrasound. Live weight and ultrasound measurements of muscle thickness were obtained before second pasture season at the average age of 744 days (24 months and 14 days). The live weight was 487.05 kg and the average lifetime daily gain was 614.16 g/day. The average muscle thickness measured by ultrasound was 45.28 mm on shoulder, 55.08 mm on loins and 95.35 mm on rump. The score for muscle development had the highest statistically significant coefficient correlation with live weight at measurement ($r_p = 0.36–0.46$). Similarly, the average daily gain had a significant relationship with the score for muscle development. The score for muscle development on the back and rump had significant correlation coefficients with muscle and whole tissue thickness. It means that with increasing growth intensity it is possible to increase muscle development in Pinzgau population. Statistically significant correlation coefficients between the objectively measured muscle thickness and the score for muscle development proved that the score for muscle development describes correctly the musculature of animals. More research is needed for better characteristics of Pinzgau cattle as rustically breed able to produce heavy weaners in the system of suckler cows (cow – calf production) in low input production scheme. Special selecting scheme creation is also needed for Pinzgau young breeding stock in this production system.

Keywords: *Slovak Pinzgau cattle, ultrasound, muscle thickness, average daily gain*

INTRODUCTION

As a consequence of the farm animal breeding and intensive use of a relatively small number of breeding stock, there is a progressive decrease in genetic variability. The loss of genetic variability can lead to the decrease of breed adaptability, worsening of the health state and finally to reduction of its farm use. Many of the original (autochthonous) farm animal breeds, which were replaced by more efficient breeds in the past, are now endangered and preserved “*in situ*” as small populations in some regions. The possible extinction of these breeds would also mean irrecoverable loss of the genetic variability and thus the loss of unique gene and allele combinations that could be very useful in the future, e.g. for the generation of new farm animal genotypes. The Slovak Pinzgau cattle belong to these endangered breeds in the Slovak republic.

Since early 90's, there is a visible decreasing trend of Pinzgau cattle population in Slovakia. Milk production has been the most important trait in the majority of farms. Pinzgau cows were considered as not sufficient in milk yield and this led to crossing with dairy breeds, mostly Red Holstein. Pinzgau is, however, suitable to highly extensive production systems (low input) using seasonal grazing of permanent pastures in the mountain region of Slovakia. Its walking ability, rusticality and overall robustness with milk production above 3500 kg from grazing allow producing of heavy weaners for later fattening in suckler cow production systems. Kica et al. (2001) proved that young bulls of the breed are good for fattening [2]. In our previous work we proved that muscle thickness of Pinzgau bulls is slightly smaller than that of Simmental, but significantly higher than that Holstein bulls [4]. Farmers in the mountain regions have not been competitive in comparison to the lowland dairy farms and have been changing production from dairy to beef in the system of suckler cows. This trend is visible in Table 1 after year 2008. In 2008, a significant decrease in the numbers of milk recorded Pinzgau cows was registered in three consequent years there is a trend towards increase.

Breeding year	Number of first lactations	Milk yield in first lactation	Total number of lactations	Average milk yield in all lactations	Finished lactations per cow	Percentage of cows under performance control	Number of cows under beef performance control	Calves under beef performance control
2011/2012	525	4044	2299	4567	3.40	82.00	1071	623
2010/2011	607	3756	2564	4420	3.57	82.20	1943	608
2009/2010	584	3755	2865	4506	3.64	85.12	1589	569
2008/2009	807	4155	3978	4777	3.65	80.82	1490	492
2007/2008	762	4015	3798	4653	3.75	70.17	1628	673
2006/2007	926	3943	4553	4543	3.35	85.63	1853	883

Source: Breeding Services of Slovak Republic, State Enterprise, Results of milk, beef and suckler cows performance control in Slovakia, 2008, 2009, 2010, 2011, 2012 and 2013.

The aim of the study was to examine suitability of the scale for linear evaluation of muscle development based on the scale used for Aberdeen Angus breed for linear evaluation of exterior of Slovak Pinzgau cattle. Another aim was to measure thickness of muscle on three important body parts and to study the relationships between muscle development and muscle thickness measured by ultrasound.

MATERIAL AND METHODS

Eighty-five Slovak Pinzgau heifers from 3 different herds located in the mountain regions of northern Slovakia were used in this study. The animals were born in 2010–2012, were measured and their exterior was evaluated at the age of 24 months, before the second grazing season in their life. The age was selected due to the fact that the growth ability and muscle thickness are minimally affected by the pregnancy at this age because heifers are just before the first conception or only in a very early stage of pregnancy. Nine grades scale (1 is minimum and 9 is maximum) was used for linear evaluation of muscle development. This scale is routinely used for linear evaluation of exterior in Slovak Beef Cattle Breeders' Association. Scoring was performed by a trained specialist in the same day when ultrasound measurements and live weights were obtained.

Growth intensity was calculated for the period between birth and age at measurement. Ultrasound measurements of *musculus infraspinatus* on shoulder blade, *musculus longissimus thoracis at lumborum* at loins and *musculus gluteus medius* above *os ischi* on rump were obtained according to the methodology published in the article Polák et al. 2001 at the age of 24 months (before the second pasture season) [3]. Echocamera Aloka PS2 with probe UST 4403, 3.5 MHz; 1720 mm was used for measuring muscle thickness. The basic statistics of each measured variable and the correlation coefficients among the grades for muscle development and ultrasound measurements were calculated by procedures STAT and REG in statistical package SAS 9.2.

RESULTS AND DISCUSSION

It is difficult to discuss our results with other authors because Pinzgau cattle and its beef production or muscle development have not been analysed or there were the results of bulls or steers in different conditions. Live weight and ultrasound measurements of muscle thickness were obtained before the second pasture season at the average age of 744 days (24 months and 14 days). The live weight was 487.05 kg and the average lifetime daily gain was 614.16 g/day. The average score for muscle development in Pinzgauer heifers at 3 evaluated positions was more or less the same; 5.48 on shoulders, 5.22 on back and 5.44 on rump. The range between minimum and maximum was 3 to 8. This result is in agreement with the commonly accepted fact that in an ordinary herd it is hard to find animals in positive or negative extremes. The basic statistics of measured vari-

ables are presented in Table 2. The average muscle thickness measured by ultrasound in our group was 45.28 mm on shoulders, 55.08 mm on loins and 95.35 mm rump (Fig. 1). In our previous studies ultrasound measurements were lower [4, 5]. This difference can be due to the fact that in those studies young bulls were used, 9 months younger than the heifers in our study and the steers kept in extensive pastures in high latitude. Muscle thickness lower by 3 or 4 mm were obtained also in our previous study which focused on the same category animals but 3 months younger [1]. The layer of muscle, fat or whole tissue thickness measured by ultrasound were the lowest on shoulder and the highest on rump (Fig. 1). Fat layer measured in this study at all scanned positions was higher than that for the Limousine breed, published by Polák et al. (2013) but lower than in Pinzgau heifers in the same publication [1].

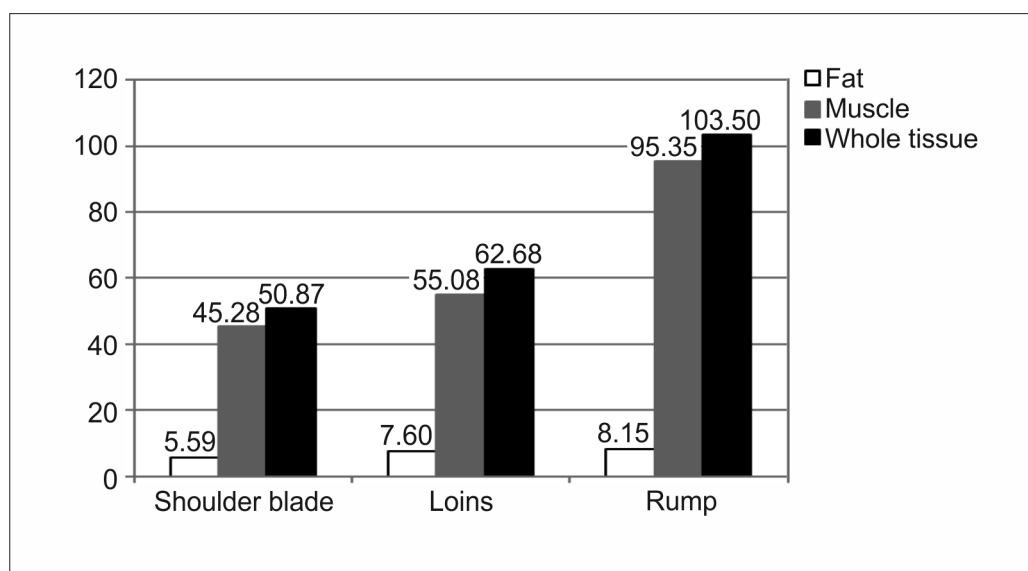


Fig. 1. Thickness of muscle, fat and whole tissue thickness (mm) measured by ultrasound on shoulder blade, loins and rump

The score for muscle development had the highest, statistically significant, correlation coefficient with live weight at measurement ($r_p = 0.36-0.46$). Similarly, the average daily gain significantly correlated with the score for muscle development (Table 3). The score for muscle development on back and rump had significant correlation coefficients with muscle and whole tissue thickness (Table 4). It means that with increasing growth intensity, it is possible to increase the muscle development in Pinzgau population. Statistically significant correlation coefficients between the objectively measured muscle thickness and the score for muscle development proved that score for muscle development describes correctly the musculature of animals. The correlation coefficients be-

Table 2. Basic statistics of measured variables				
Variable	Mean	Standard deviation	Minimum	Maximum
Muscle development on shoulder blade	5.48	0.78	4.00	7.00
Muscle development on back	5.22	0.84	3.00	7.00
Muscle development on rump	5.44	0.85	4.00	8.00
Total score for muscle development	16.13	2.18	11.00	22.00
Daily gain (g. day ⁻¹)	614.16	84.66	445.47	852.73
Age at measurement (days)	744.22	68.76	606.00	993.00
Live weight at measurement (kg)	487.05	60.90	333.00	640.00
Proportion of muscle in whole tissue layer on shoulder blade (%)	88.81	3.02	80.86	95.92
Proportion of muscle in whole tissue layer on back (%)	87.72	2.33	82.54	91.95
Proportion of muscle in whole tissue layer on rump (%)	92.04	2.12	86.18	96.03

Table 3. Correlation coefficients of grades for muscle development and selected variables of growth intensity			
Variable	Live weight at measurement	Age at measurement	Average daily gain
Muscle development on shoulder blade	0.36+++	0.17	0.25+
Muscle development on back	0.46+++	0.31++	0.26+
Muscle development on rump	0.41+++	0.14	0.32++
Total score for muscle development	0.46+++	0.23+	0.31++

Table 4. Correlation coefficients of grades for muscle development and ultrasound measurements				
Variable	Muscle thickness	Fat thickness	Whole tissue thickness	Proportion of muscle in whole tissue layer
Muscle development on shoulder blade	0.16	-0.04	0.15	0.11
Muscle development on back	0.36+++	0.05	0.35+++	0.24+
Muscle development on rump	0.25+	0.04	0.26+	0.06

tween grades for muscle development and selected variables of growth intensity and ultrasound measurements showed that the best ability to characterise animal muscling is muscle development on back.

CONCLUSIONS

Statistically significant correlation coefficients between the objectively measured muscle thickness and the score for muscle development proved that the score for muscle development describes correctly the musculature of animals. The correlation coefficients

between the grades for muscle development and the selected variables of growth intensity and ultrasound measurements showed that the best ability for beef characterisation of beef production is muscle development on the back.

More research is needed for better characteristics of Pinzgau cattle as rustically breed able to produce heavy weaners in system of suckler cows (cow–calf production) in low input production scheme. Special selecting scheme creation is also needed for Pinzgau young breeding stock in this production system.

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PERFORMANCE TRAITS OF LITHUANIAN PIG GENETIC RESOURCES TESTED IN TWO DIFFERENT ENVIRONMENTS

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ABSTRACT

The pigs used in the study were purebred Lithuanian Indigenous Wattle and old genotype Lithuanian White pigs evaluated under farm test and under control station test. The traits evaluated and analysed are those recorded at performance testing in nucleus herds, using Piglog 105 equipment and performance testing in the control station by both Piglog 105 and carcass measurements. The data were subjected to analysis of variance in general linear (GLM) procedure in SPSS 17 with LSD tests to determine the significance of differences of means between the groups. The test environment affected the performance traits of both Lithuanian pig breeds. The growth rate from birth to testing under farm test was by 5 % and 6.8 % lower ($P < 0.001$), respectively, for Lithuanian White and Lithuanian Indigenous Wattle pigs compared with pigs tested under control test station. The ultrasonic measurements showed that fat thickness measured at point Fat 1 under station test before the slaughter was 6.28 mm for Lithuanian Indigenous Wattle and 6.38 mm for Lithuanian White pigs higher ($P < 0.001$) than for pigs under farm test. The differences in fat thickness measured at point Fat 2 between the station and farm tests were lower. The mean value for Fat 2 under station test was 4.69 and 5.72 mm for Lithuanian Indigenous Wattle and for Lithuanian White pigs, respectively, higher ($P < 0.001$) than for the pigs under farm test. The muscle depth measured under farm test was by 5.1 % higher ($P < 0.01$) for Lithuanian White and 7.3 % higher ($P < 0.001$) for Lithuanian Indigenous Wattle pigs compared with the station test. The gender of tested pigs showed significant effect on fat and muscle measurements. The lowest and highest fat thickness ($P < 0.001$), respectively, was shown by entire and castrated males from both breeds. The backfat thickness of Lithuanian Indigenous Wattle and Lithuanian White females at

10th rib under station test was, respectively, 5.37 mm and 5.98 mm higher ($P < 0.001$) than at point Fat 2 under farm test. The differences found between the two test environments show higher adaptability of conserved Lithuanian pig breeds for extensive farming in small scale systems. The differences between the data from farm and station tests also are problematic with respect to the breeding value estimation.

Keywords: test environment, backfat thickness, pigs, breed, gender

INTRODUCTION

Since the last century when the old breed of Lithuanian indigenous wattle pigs had been restored at the Institute of Animal Science large scale of Lithuanian White pig breed erosion have turned due to changing pig production system and conditions. As a consequence to the increased market demand for leaner pork, Lithuanian pig production made great strides to reduce the fat content of pig carcasses and improve the leanness of pork through the use of only lean foreign breeds or as a solitary instance by absorptive Lithuanian White pigs with lean breeds. All this resulted in the decline of purebred Lithuanian White pigs in numbers. Consequently, both Lithuanian pig breeds, owing to their small population sizes which are lower than 100 of adult animal, are at risk of their disappearance. Therefore both Lithuanian pig breeds are the subject of farm animal conservation program the aim of which is to maintain small populations and search for possibilities to increase the populations through their wider use [9]. Rare breeds need to be valorized by being associated with development initiatives. Valorizing rare breeds is one of the ways to encourage breeders to keep them. Most development initiatives are concerned with the valorization of a food product associated with a particular breed or with a specific landscape on an extensive farming system [6]. The future market for pork will be more heterogenous and dynamic, thereby asking for more market oriented activities in this chain, at slaughterhouse, farmer and breeding stages [17]. There are various approaches based on breeding planning aiming to achieve effective breeding in smallholder production systems and these systems should be characterised and the role of the animals within the system should be evaluated [3]. Beside the own organisation, various other institutions are potential suppliers of data, for example, performance testing stations, slaughterhouses [3]. Therefore, the objective of this study was to estimate the parameters of Lithuanian Indigenous Wattle and old genotype Lithuanian White pig performance under the conditions of farm and control station tests.

MATERIAL AND METHODS

Nine hundred-eighty pigs were used in the study. These pigs were purebred Lithuanian Indigenous Wattle and old genotype Lithuanian White pigs. The study included the material from four hundred-ten Lithuanian Indigenous Wattle pigs (216 gilts, 163 barrows

and 31 entire boars) and five hundred-fifty-four pigs of the Lithuanian White pig breed (326 gilts, 201 barrows and 27 entire boars). All pigs were born at the Institute of Animal Science of the Lithuanian University of Health Sciences. Two hundred-seven pigs, including gilts and entire boars, were evaluated under farm test and seven hundred-fifty-seven pigs, including gilts and barrows, were evaluated under control station test. The traits evaluated and analysed are those traits recorded at the performance testing in nucleus herds, using Piglog 105 equipment and performance testing in the control station using both Piglog 105 and carcass measurements. Ultrasonic measurements to estimate backfat thickness and muscle depth were made by Piglog 105 equipment 7 cm from the midline between 3/4 lumbar vertebra (Fat 1) and between 3/4 last rib (Fat 2 and muscle depth). These measurements were also used to predict the lean meat content of the pigs. The ultrasonic measurements were made and all data were collected by control-assistants both under farm test as a part of the on farm testing program and under station test before the pig slaughter. The station test was applied for piglets from 30 to 110 kg. With the aim to compare growth rates, the growth rate for all pigs from birth to testing at 85–110 kg was calculated. The slaughtering was conducted with a minimum handling stress in the abattoir for control slaughtering of the State Pig Breeding Station. Eviscerated and split longitudinally down the midline carcasses were chilled for 24 h at +2–4°C. Twenty-four hours post-mortem the chilled carcasses were evaluated. The measurements of midline backfat thickness were carried out with a ruler on the left side of cold carcasses at the crest, at 6/7, 10, at the last rib, at the thinnest lumbar backfat point and at three points over the *gluteus medius* (the anterior part, above the highest point and at the posterior part). However, the backfat thickness analysed in the present study and compared with the ultrasonic backfat thickness at point Fat 2 is the backfat thickness at 10 rib. Concerning pig weight differences at testing, fat and muscle depth measurements for females were additionally pre-corrected to a testing weight of 100 kg according to Lundeheim [7, 8]. The following formulas were used for this pre-correction:

$$\begin{aligned}\text{fat2 (mm)} &= \text{fat2} - (\text{kg} - 100) \times 0.1; \\ \text{loin (mm)} &= \text{loin} - (\text{kg} - 100) \times 0.2.\end{aligned}$$

The data were subjected to the analysis of variance in general linear (GLM) procedure in SPSS 17 with LSD tests to determine the significance of differences of means between the groups. The differences were regarded as significant when $P < 0.05$.

RESULTS AND DISCUSSION

Test environment affected the performance traits of both Lithuanian pig breeds. The growth rate from birth to testing under farm test was by 5 % and 6.8 % lower ($P < 0.001$), respectively, for Lithuanian White (Table 1) and Lithuanian Indigenous Wattle (Table 2)

pigs compared with the pigs tested under control test station. Both Lithuanian pig breeds are not lean breeds and their selection should be desirable. In the literature, response to selection has been shown to be positively influenced by the accuracy of measurement, the intensity of selection and the amount of variation available. All these are facilitated by a large population size. In large herds it is also easier to minimise generation interval [18]. Although, the populations of Lithuanian pig breeds are very small and possibilities for their further selection are limited, the accuracy of their measurements and pig evaluation is very important.

Table 1. Performance traits of Lithuanian White pigs measured in two test environments and by gender								
Variables	Test environment				Gender			
	Farm	Station	SED	P-value	Gilts	Entire males	Castrated males	P-value
Age, days	187.6	184.3	1.82	0.068	188.8 ^a	184.0	182.3 ^b	0.002
Weight, kg	92.6	96.2	0.50	<0.001	93.9 ^a	93.7 ^c	96.2 ^{b,d}	0.055
Daily gain, g	500	525	0.01	<0.001	501 ^a	516	530 ^b	<0.001
Fat 1, mm	17.46	23.84	0.58	<0.001	19.74 ^{a,c}	17.26 ^{a,d}	25.88 ^b	<0.001
Fat 2, mm	17.08	22.80	0.60	<0.001	19.26 ^{a,c}	16.59 ^{a,d}	24.66 ^b	<0.001
Muscle depth, mm	39.93	38.01	0.73	0.008	39.58 ^a	39.85 ^e	36.87 ^{b,f}	<0.001
Lean, %	52.80	46.92	0.55	<0.001	50.85 ^{a,e}	52.81 ^{a,f}	44.93 ^b	<0.001
SED – standard error of difference; a-b P < 0.001; c-d P < 0.01; e-f P < 0.05								

Table 2. Performance traits of Lithuanian indigenous wattle pigs measured in two test environments and by gender								
Variables	Test environment				Gender			
	Farm	Station	SED	P-value	Gilts	Entire males	Castrated males	P-value
Age, days	198.5	189.6	2.24	<0.001	194.3 ^c	199.1 ^c	188.4 ^d	0.475
Weight, kg	92.5	95.3	0.79	<0.001	92.7 ^a	94.6	95.6 ^b	0.009
Daily gain, g	472	504	0.01	<0.001	482 ^a	480 ^a	509 ^b	0.043
Fat 1, mm	20.57	26.78	0.61	<0.001	22.81 ^{a,c}	20.16 ^{a,d}	28.92 ^b	<0.001
Fat 2, mm	20.95	25.64	0.62	<0.001	22.19 ^a	21.03 ^a	27.76 ^b	<0.001
Muscle depth, mm	39.84	37.13	0.76	<0.001	39.17 ^a	39.42 ^c	36.16 ^{b,d}	0.022
Lean, %	49.54	44.03	0.59	<0.001	47.70 ^{a,c}	49.81 ^{a,d}	41.93 ^b	<0.001
SED – standard error of difference; a-b P < 0.001; c-d P < 0.01								

The ultrasonic measurements showed that the fat thickness measured at point Fat 1 under station test before the slaughter was 6.28 mm or 30.2 % for Lithuanian Indigenous Wattle and 6.38 mm (36.5 %) for Lithuanian White pigs higher ($P < 0.001$) than

for the pigs under farm test. The differences in the fat thickness measured at point Fat 2 between the station and farm tests were lower. The mean value for Fat 2 under station test was by 4.69 mm or 22.4 % for Lithuanian Indigenous Wattle and 5.72 mm or 33.5 % for Lithuanian White pigs higher ($P < 0.001$) than for the pigs under farm test. The muscle depth measured under farm test was by 5.1 % higher ($P < 0.01$) for Lithuanian White and by 7.3 % higher ($P < 0.001$) for Lithuanian indigenous wattle pigs compared with the station test. The higher muscle depth and lower fat measurements under farm test also resulted in higher ($P < 0.001$) lean meat contents for the pigs of both breeds compared with the station test. Both farm and station tests use ultrasonic measurements with Piglog 105 equipment to estimate backfat thickness, muscle depth and lean meat content, and all measurements were made by the same control-assistants. Olsen et al. [15] have reported that contingencies imply that it is not possible to repeat the carcass measurements in exactly the same way and obtain exactly the same value every time. Consequently, measurements on live pigs and different environmental factors may cause higher deviations from the true value. The differences between the farm and station tests could be found not only due to the different growth rate but also due to the different gender of pigs used on these tests. As it was expected, the gender of the tested pigs showed significant effect on fat and muscle measurements. Lower growth rate of the females from the both breeds differed only by 5.6–6.0 % ($P < 0.001$) from entire males, however, the differences in fat thickness between the genders were significantly higher. The lowest and highest fat thickness ($P < 0.001$), respectively, was shown by entire and castrated males from both breeds. This is in agreement with our previous studies [10, 11]. High effect of gender was described also in different studies by other authors [5, 13]. Farm testing evaluates both females and entire males, however, station testing is adopted to evaluate only females and castrated males. Moreover, the body weight of pigs measured under station test was 2.8 kg and 3.6 kg higher ($P < 0.001$), respectively, for Lithuanian Indigenous Wattle and Lithuanian White pigs compared with the body weight of the pigs measured under farm test. Fat content is generally considered to be independent of either live animal weight or carcass weight. As pig and carcass weight increase, there is a significant increase in lipid content, including subcutaneous fat [1, 4, 5, 14]. In Germany for a more reliable prediction of future genetic progress in commercial farms, there is an offer for adjustment of the final weight of pigs under test to the final weight on the commercial level [2].

Therefore, in the present study for females the fat and muscle depth measurements were pre-corrected to a testing weight of 100 kg. The differences between the pre-corrected fat and muscle measurements of the females under farm and station tests were lower than for the all tested pigs. The mean value for Fat 1 under station test was 3.67 mm or 19.8 % for Lithuanian White (Table 3) and 2.64 mm or 12.1 % for Lithuanian indigenous wattle females (Table 4) higher ($P < 0.001$) than for the females under farm test.

Table 3. Comparative evaluation of Lithuanian White gilt fatness under control station and farm tests				
Variables	Test environment		SED	P-value
	Station	Farm		
Age, days	186.3	191.2	1.95	0.011
Weight, kg	96.3	91.5	0.56	<0.001
Daily gain, g	519	484	0.01	<0.001
Precorrected measurements: Fat1, mm	22.20	18.53	0.57	<0.001
Fat2, mm	21.33	18.43	0.65	<0.001
Muscle depth, mm	39.88	41.72	0.70	0.009
Backfat at 10 th rib to Fat 2, mm	24.41	18.43	0.92	<0.001

Table 4. Comparative evaluation of Lithuanian indigenous wattle female fatness under control station and farm tests				
Variables	Test environment		SED	P-value
	Station	Farm		
Age, days	190.0	197.8	3.98	0.052
Weight, kg	95.8	90.5	0.96	<0.001
Daily gain, g	499	474	0.01	<0.001
Precorrected measurements: Fat1, mm	24.48	21.84	0.61	<0.001
Fat2, mm	23.77	21.71	0.67	0.003
Muscle depth, mm	39.98	42.15	0.92	0.021
Backfat at 10 th rib to Fat 2, mm	27.08	21.71	0.64	<0.001

The mean value for Fat 2 under station test was by 2.90 mm or 15.7 % ($P < 0.001$) for Lithuanian White and by 2.06 mm or 9.5 % ($P < 0.01$) for Lithuanian Indigenous Wattle females higher than for the pigs of the same gender under farm test. The muscle depth measured under farm test was by 1.84 mm (4.6 %) higher ($P < 0.01$) for Lithuanian White and by 2.17 mm (5.4 %) higher ($P < 0.001$) for Lithuanian Indigenous Wattle females compared with the station test. The previous study [12] indicated that the mean of fat thickness at point Fat 2 measured under station test by ultrasonic equipment *Piglog 105* on live Lithuanian White old genotype and Lithuanian Indigenous Wattle pigs before their slaughter was analogous to the mean backfat thickness at 10th rib measured on their carcass. However, in this study the comparison of fat thickness at Fat 2 point measured under farm test and backfat thickness at 10th rib measured on the carcasses from pigs of the same gender grown in a control test station did not confirm this analogy. Moreover, the differences between the means of backfat thickness at 10th rib under station test and at point Fat 2 under farm test were 5.37 mm and 5.98 mm ($P < 0.001$) for Lithuanian Indigenous Wattle and Lithuanian White females, respectively. Pringle and Williams [16] have reported that all measurements of backfat depth increased on carcasses as 10th rib backfat thickness category increased. Although the growth rate of females under station test was higher ($P <$

0.001) only by 5.3 % for Lithuanian Indigenous Wattle and 7.2 % for Lithuanian White females, their fatness evaluated under station test was significantly higher than under farm test. Habier et al. [2] have reported about differences between the variance components in the two German test stations and concluded that the genetic progress on test stations is expected to be lower in the future. The differences found between the two test environments in this study show higher adaptability of the conserved Lithuanian pig breeds for extensive farming in small scale systems. The differences between the data from farm and station tests are also problematic with respect to the breeding value estimation. For a more reliable prediction of pig performance, farm and station tests should be adjusted to each other.

CONCLUSIONS

1. Test environment and gender of tested pigs affected the performance traits of Lithuanian Indigenous Wattle and Lithuanian White old genotype pig breeds.
2. The growth rate from birth to testing under farm test was by 5 % and 6.8 % lower ($P < 0.001$), respectively, for Lithuanian White and Lithuanian Indigenous Wattle pigs compared with the pigs tested on a control test station. The ultrasonic measurements showed that fat thickness measured at point Fat 1 under station test before the slaughter was by 6.28 mm for Lithuanian Indigenous Wattle and 6.38 mm for Lithuanian White pigs higher ($P < 0.001$) than for the pigs under farm test. The mean value for Fat 2 under station test was by 4.69 mm for Lithuanian Indigenous Wattle and 5.72 mm for Lithuanian White pigs higher ($P < 0.001$) than for the pigs under farm test.
3. The muscle depth measured under farm test was by 5.1 % higher ($P < 0.01$) for Lithuanian White and 7.3 % higher ($P < 0.001$) for Lithuanian Indigenous Wattle pigs compared with the station test.
4. The backfat thickness of Lithuanian Indigenous Wattle and Lithuanian White females at 10th rib under station test was, respectively, 5.37 mm and 5.98 mm higher ($P < 0.001$) than at point Fat 2 under farm test.
5. The difference between the data from farm and station tests also is problematic with respect to the breeding value estimation. For a more reliable prediction of pig performance, farm and station tests should be adjusted to each other.

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LIETUVOS KIAULIŲ GENETINIŲ IŠTEKLIŲ, ĮVERTINTŲ SKIRTINGOJE VERTINIMO APLINKOJE, PRODUKTYVUMO RODIKLIAI

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SANTRAUKA

Lietuvos vietinės ir senojo genotipo Lietuvos baltosiosios kiaulės buvo įvertintos skirtingomis bandos ir kontrolinio penėjimo stoties sąlygomis. Atlikta veislinėse bandose vertinamų ir kaupiamų duomenų, gautų taikant gyvų kiaulių vertinimą ultragarso prietaisais bandoje ir stotyje bei skerdenų vertinimą, analizė. Statistinė duomenų analizė atlikta taikant dispersinės analizės apibendrintąjį tiesinį SPSS 17 paketo modelį (GLM). Tarp grupiniai skirtumai įvertinti pagal LSD kriterijų. Nustatyta, kad vertinimo aplinka padarė didelę įtaką abiejų tirtų kiaulių veislių produktyvumo požymiams. Augimo sparta nuo gimimo iki Lietuvos baltųjų ir Lietuvos vietinių kiaulių vertinimo bandoje buvo atitinkamai 5 ir 6,8 % mažesnė ($P < 0,001$) negu kontrolinio penėjimo stotyje. Vertinimas ultragarsu parodė, kad Lietuvos vietinės ir Lietuvos baltąsias kiaules vertinant kontrolinio penėjimo stotyje, jų lašinių storis taške Fat 1 buvo atitinkamai 6,28 ir 6,38 mm storesni ($P < 0,001$) negu vertinant bandoje. Lašinių storio taške Fat 2, nustatyto kontrolinio penėjimo stotyje ir bandoje, skirtumas buvo kiek mažesnis. Lietuvos vietinės ir Lietuvos baltąsias kiaules vertinant kontrolinio penėjimo stotyje, jų lašinių storis taške Fat 2 buvo atitinkamai 4,69 ir 5,72 mm storesni ($P < 0,001$) negu vertinant bandoje. Lietuvos baltųjų ir Lietuvos vietinių kiaulių, įvertintų bandoje, raumens gylis buvo atitinkamai 5,1 ($P < 0,01$) ir 7,3 % ($P < 0,001$) didesnis negu vertinant stotyje, nors visus matavimus atliko stoties specialistai. Šiuos rodiklius tam tikra dalimi įtakuoja ir kiaulių lytis, nes mažiausiu ir didžiausiu riebumu ($P < 0,001$) išsiskyrė abiejų veislių kuiliukai ir kastratai. Lyginant vien pagal svorį vertinimo metu patikslintus kiaulaičių duomenis, skirtumai buvo mažesni, tačiau Lietuvos vietinių kiaulaičių skerdenų lašinių storis ties 10 šonkauliu buvo 5,37 mm, o Lietuvos baltųjų kiaulaičių – 5,98 mm didesnis ($P < 0,001$) negu šiai matavimo vietai artimame taške Fat 2, vertinant kiaulaites bandoje. Nustatyti skir-

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tumai, vertinant saugomų veislių kiaules skirtingose sąlygose, parodė didesnę šių veislių prisitaikymą ekstensyvesnio auginimo sąlygoms. Gauti skirtingi kontrolinio penėjimo ir savo bandos sąlygomis kiaulių vertinimo duomenys parodo kiaulių vertinimo metodų adekvatumo trūkumą ir veislinės vertės nustatymo tikslumo padidinimo poreikį.

Raktažodžiai: vertinimo aplinka, lašinių storis, kaulės, veislė, lytis

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ПОКАЗАТЕЛИ ПРОДУКТИВНОСТИ ГЕНЕТИЧЕСКИХ РЕСУРСОВ ЛИТОВСКИХ ПОРОД СВИНЕЙ, ПРОВЕРЕННЫХ В РАЗНОЙ ОКРУЖАЮЩЕЙ СРЕДЕ

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РЕЗЮМЕ

Литовские местные и литовские белые свиньи старого генотипа были проверены в разных условиях окружающей среды стада и станции контрольного откорма свиней. Статистический анализ данных оценки свиней с помощью ультразвукового аппарата Piglog 105 в стаде и станции контрольного откорма и оценки туш свиней, выращенных на станции был проведен при использовании GLM статистического пакета SPSS-17. Было установлено, что окружающая среда выращивания и оценки свиней оказало значительное влияние на показатели продуктивности обеих пород. Скорость роста от рождения до оценки свиней на станции у литовских белых и литовских местных свиней была на 5 и 6,8 % выше ($P < 0,001$), чем у свиней, проверенных в стаде. Оценка признаком показала, что толщина сала в точке Fat 1 у литовских местных и литовских белых свиней, проверенных на станции контрольного откорма была соответственно, на 6,28 и 6,38 мм выше ($P < 0,001$), чем у свиней, проверенных в стаде. Разница толщины сала в точке Fat 2 у свиней, проверенных на станции и в своем стаде была меньше: у литовских местных и литовских белых свиней, соответственно, на 4,69 и 5,72 мм. Толщина мышцы у литовских

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белых свиней проверенных в стаде была на 5,1 % ($P < 0,01$), а у литовских местных на 7,3 % ($P < 0,001$) больше, чем у свиней, проверенных на станции. Разницу данных свиней, проверенных на станции и в стаде способствовало не только разница в интенсивности роста, но и влияние пола. На станции проверены кастраты отличались наибольшей, а хрячки, проверены в стаде наименьшей жирностью ($P < 0,001$). Разница толщины сала у свинок после коррекции данных, учитывая разницу их веса у проверяемых свиней на станции и в стаде, была меньше, но толщина сала у 10 ребра измеренная на туше у литовских местных свинок была на 5,37 мм, а у литовских белых свинок на 5,98 мм больше ($P < 0,001$), чем толщина жира в точке Fat 2 у свинок соответственных пород проверенных в стаде ультразвуковым аппаратом. Разница в данных продуктивности свиней, проверенных в условиях разной окружающей среды, показала лучшее приспособление к более экстенсивным условиям выращивания свиней литовских пород и недостаток адекватности методов оценки и потребность увеличения точности оценки свиней.

Ключевые слова: среда оценки, толщина сала, свиньи, порода, пол

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ANALYSIS OF SCRAPIE GENOTYPE OF LATVIAN DARKHEAD SHEEP GENETIC RESOURCES

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ABSTRACT

Latvia implements the program for sheep breeds developed in Latvia "Conservation of farm animal genetic resources" which includes the Latvian darkhead sheep breed. During the last 5 years the implementation of Latvian darkhead breed conservation program has been proceeding successfully. The interest in using purebred rams for coupling with ewes and, thus, arriving at genetically homogeneous herds has grown.

The aim of Latvian darkhead breed conservation is to preserve a part of Latvian darkhead animals as a genetic reserve without mixing their blood with unkindred breeds in the next generations. It is advisable to use Latvian darkhead sheep for coupling purposes as a "mother" breed, since it features good fertility, milkiness, well developed motherhood, strong constitution, resistance to illnesses, suitability to local conditions. All mentioned characteristics are very important for breeders to use in the future, too.

In 2012 and 2013 The Latvian Association of Sheep Breeders in cooperation with its German partner EUROFINS Medigenmix laboratory specializing in blood typing, determined the genotypes of classical scrapie for 586 Latvian darkhead sheep and 42 breed rams from 25 Latvian breeding farms.

From Latvian darkhead genetic resource animals, 21 % of ewes and 24 % of breed rams could be included in R1 risk group, while 44 % of ewes and 48 % of breed rams were put in R2 risk group and could be safely used for reproduction of breed flock.

Keywords: *scrapie, genetic resources, sheep breeds, genotype, resistance*

INTRODUCTION

Latvia implements the program for sheep breeds developed in Latvia "Conservation of farm animal genetic resources" which includes the Latvian darkhead sheep breed. During the last 5 years the implementation of Latvian darkhead breed conservation program has been proceeding successfully. The interest in using purebred rams for coupling with ewes and, thus, arriving at genetically homogeneous herds has grown.

The aim of Latvian darkhead breed conservation is to preserve a part of Latvian darkhead animals as a genetic reserve without mixing their blood with unkindred breeds in the next generations. It is advisable to use Latvian darkhead sheep for coupling purposes as a "mother" breed, since it features good fertility, milkiness, well developed motherhood, strong constitution, resistance to illnesses, suitability to local conditions. All mentioned characteristics are very important for breeders to use in the future, too.

Local animals have a strong constitution and ability to pass the vitality to their progeny. Therefore, it is considered that Latvian darkhead sheep can serve as a genetic reserve for sheep population diversity.

The Latvian darkhead sheep breed was developed in the twenties and thirties of the last century by coupling the local Coarsewool sheep with Shropshire and Oxfordshire rams which were brought in from Sweden and England. As a result of targeted work, Latvian darkhead sheep have been developed with a high reproductive capacity, good precocity and excellent quality of flesh. The live weight of ewes is 55–65 kg, and that of breeding rams – 100–120 kg. Fertility is evaluated at 150–160 % and lamb live weight gain until weaning varies from 150 to 250 g [4].

Just like Bovine Spongiform Encephalopathy (BSE), and Creutzfeldt-Jakob disease (CJD) in human beings, in case of sheep (*Ovis aries*) and goats (*Capra aegagrus hircus*) scrapie (*chesmus ovium*) disease belongs to Transmissible Spongiform Encephalopath (TSE) group. This disease features lethal degenerative central nervous system disorders with particular accumulation of pathologic isoform (PrP^{Sc}) in the prion protein (PrP^c) of brain cells [9, 11]. The disease was first described in England in the 18th century. This contagious disease has been observed in European sheep flocks for more than 250 years, and it has been spreading to many other countries of the world. After getting this infection, the incubation period is 2–6 years. The disease caused economic losses, yet it was never thought of as a risk factor for human health. Molecular structures of the infection agent causing TSE diseases are still unknown.

According to the studies of several scientists who used both healthy and infected sheep, it was established that susceptibility to classical scrapie is influenced by polymorphism of prion protein amino acids at codon positions 136, 154 and 171 [3]. Mutations in amino acid proteins can be observed at these codons. Replacement of one nucleotide (G; A; C; U) can cause replacement of one amino acid in protein structure which in turn leads to altered protein (PrP^{Sc}). For instance, amino acid valine (V) or alanine (A) can be

replaced in 136 position protein sequence, while arginine (R) or histidine (H) can be replaced in 154 position protein sequence and glutamine (G), arginine (R) or histidine (H) can be replaced in 171 position protein sequence [5, 12]. Mutations are related to sheep's susceptibility or resistance to scrapie. Five main haplogroups – ARR, ARO, AHO, VRO and ARH – are determined on the basis on amino acid polymorphism in these positions. Homozygous animals (ARR) are more resistant to classical scrapie but in case of few rare combinations such as ARQ, VRR and AHR, there is no clear evidence about the susceptibility or resistance to this disease [7]. In Great Britain, according to the National Scrapie Plan, all genotypes against classical scrapie (PrP^{Sc}) resistance are broken down into five risk groups from R1 to R5 where R1 (ARR/ARR) is resistant and R5 (VRQ/VRQ) is the most susceptible to this disease and, therefore, these animals cannot be used for further breeding [10].

The European Union introduced active supervision program for small ruminants against TSE diseases in 2002 [1]. Such program was introduced in Latvia in 2004 with accession to the European Union.

There are no studies about scrapie genotypes of the Latvian darkhead breed. The objective of our study was to investigate the frequency of scrapie genotype for Latvian darkhead sheep and breeding rams included in the genetic resource conservation program.

MATERIALS AND METHODS

In order for Latvian sheep breeders to be informed about the predisposition of the sheep in their flocks to classical scrapie, the Latvian Association of Sheep Breeders in cooperation with its German partner EUROFINS Medigenmix laboratory, specializing in blood typing, determined genotypes of classical scrapie in 586 Latvian darkhead sheep and 42 breed rams from 25 Latvian breeding farms which have signed the contract on implementation of the genetic resource conservation program. EUROFINS Medigenomix laboratory is a recognized and experienced private veterinary laboratory, certified according to ISO EN 9001:2000 and licensed for scrapie testing according to ISO 17025:2005. The method is based on developed and leading DNA micro scheme technology (Sequenom, WeightARRAY). For the purposes of genotype testing, we sent 1–2 ml of sheep blood samples put into specially designed vacutainers. The methods basically determines amino acid prions at three codon positions 136, 154 and 171, and consequently risk groups from G1 to G5 are attributed. Latvia follows the risk group classification from R1 to R5 (see Table 1) adopted in the United Kingdom National Scrapie Plan.

The animals which are most resistant against classical scrapie and which can be used for population breeding are included into haplogenic combination ARR risk group R1. The animals which belong to haplogenic combination VRQ risk group R5 are not

allowed to be used for population breeding. It is strictly forbidden to use animals for population breeding if amino acid threonine (T) in 136 protein sequence and lysine (K) in 171 protein sequence is found in the gene combination [2].

To see what frequencies of gene occurrence are observed in genetic resource sheep and breeding rams included in the study, we presented them according to the birth year (Table 2). The average age of sheep was 4–5 years but average age of breeding rams was 3–6 years. During the studies of ewes scrapie in Norway, the sheep breeds reared in Norway, such as Dala, Rygja, Steigar and Spæl with the average age of 6 years, have been examined [8].

Table 1. Combination of gene and risk group description for sheep breeding		
Combination of genotype	Risk group	The use of sheep breeding
ARR/ARR	R1	Resistant and used for breeding
ARR/ARQ	R2	ARR allele allows to use for reproduction
ARR/AHQ		
ARR/ARH		
AHQ/AHQ		
AHQ/ARH	R3	ARR allele absence prevents the use for reproduction, but the VRQ allele absence allows the use for reproduction in special cases (in small populations)
ARH/AHQ		
ARH/ARH		
ARH/ARQ		
ARQ/ARH		
ARQ/ARQ		
ARQ/AHQ		
ARR/VRQ	R4	In order to preserve rare breeds, it is allowed to use for reproduction at individual parental mating
ARQ/VRQ	R5	VRQ allele precludes the use of animals for reproduction
AHQ/VRQ		
VRQ/VRQ		
ARR/ARK	Reproduction categorically precluded	
ARK/ARQ		
ARR/TRQ		
ARQ/TRQ		
AHQ/TRQ		

The majority of sheep in our study were born in 2008 (129 sheep) but the majority of rams were born in 2009 (12 breeding rams).

Table 2. Number of animals and the structure by birth year

Birth year	Ewes		Rams		Total for the birth year
	n	%	n	%	
2002	3	0.51	0	–	3
2003	7	1.19	1	2.38	8
2004	12	2.05	0	–	12
2005	32	5.46	2	4.76	34
2006	34	5.80	2	4.76	36
2007	75	12.80	1	2.38	76
2008	129	22.01	3	7.14	132
2009	94	16.04	12	28.57	106
2010	122	20.82	8	19.05	130
2011	36	6.14	6	14.29	42
2012	42	7.17	7	16.67	49
Total	586	100.00	42	100.00	628

Within the framework of our study, we have determined the frequency of genotypes and scrapie risk group division according to the animal birth year of Latvian darkhead ewes and breeding rams.

The study data were processed with MS Excel data mathematical methods by calculating the distribution of genotype frequency, expressed in percent, and including the respective animals according to the risk groups.

RESULTS AND DISCUSSION

On the basis of the data of the study about the frequency of the genotypes of ewes included in the Latvian darkhead genetic resource program, it follows that the ewes can be divided into five risk groups from R1 – resistant – to R5 – with low resistance (Fig 1).

The study evidences that 21 % ewes of all genetic Latvian darkhead breed population used in the study, were either of R1 risk group or scrapie resistant sheep. These sheep are predisposed to classical scrapie and they must be used for sheep selection also in future by cultivating the animals included in the genetic conservation program for further multiplication of the breeding material. 44 % of genetic resource sheep included in the study were put in R2 risk group regardless of age. Similar results were observed in the study of gene frequencies of Latvian darkhead sheep carried out by K. Grāve, who concluded that 51.07 % of animals belong to R2 risk group [6]. The studies carried out with French sheep breeds in France from 2002 to 2004 showed that 29 % of animals were put in R2 risk group [1].

The sheep included in R3 risk group (33 %) can also be used for breeding as the lambs will have the desirable resistant gene combination.

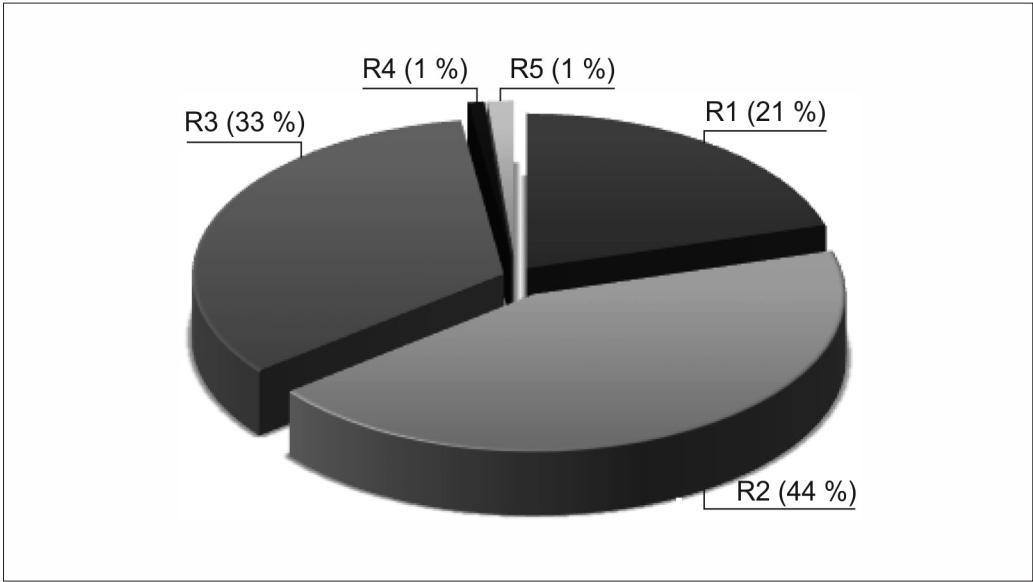


Fig. 1. Scrapie distribution of risk groups for Latvian darkhead ewes, %

The study about the frequency of genotypes of breeding rams included in Latvian darkhead genetic resource program indicated that the rams can be divided into three risk groups from R1 – the most resistant – to R3 – with neutral resistance (Fig 2).

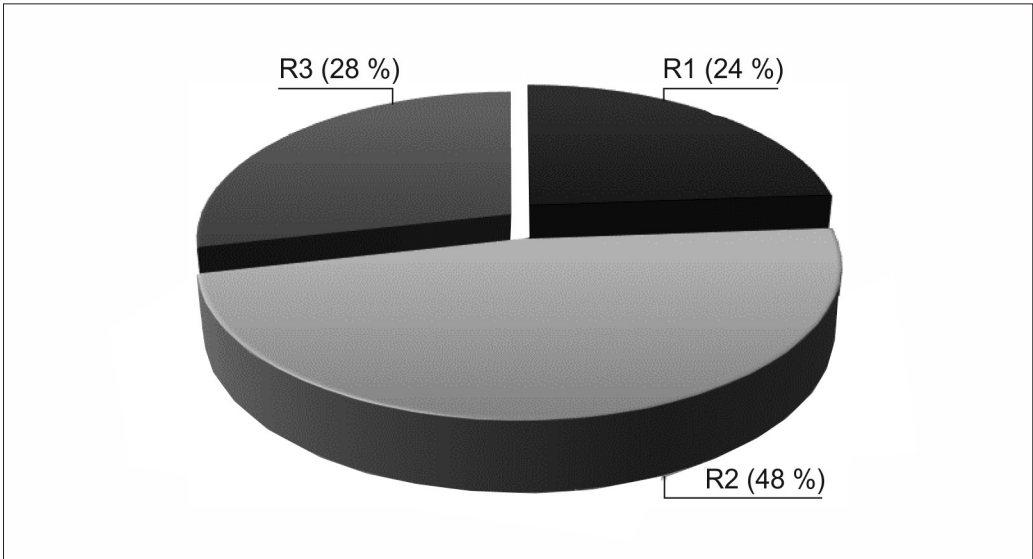


Fig. 2. Scrapie distribution of risk groups for Latvian darkhead rams, %

24 % of Latvian darkhead breed belong to R1 risk group or scrapie resistant group of breeding rams. These rams are predisposed to classical scrapie and they must be used for sheep selection also in future by cultivating the animals included in the genetic conservation program for further multiplication of the breeding material. 48 % of genetic resource breeding rams included in the study and were put in R2 risk group regardless of age.

The genetic resource breeding rams included in R3 risk group (28 %) could be used for breeding purposes provided that the sheep which they are coupled with have a resistant (R1) gene combination [2].

The scrapie genotypes found in ewes and breed rams included in the Latvian darkhead sheep genetic resource program are presented in Table 3.

Table 3. Genotype frequencies of Scrapie in the Latvian darkhead breed, %			
Genotype frequency	Risk group	Ewes	Rams
		n = 586	n = 42
ARR/ARR	R1	20.48	23.41
ARR/AHQ		0.34	–
ARR/ARH	R2	4.10	2.38
ARR/ARQ		39.42	45.24
ARQ/AHQ		0.85	–
ARQ/ARQ	R3	27.99	26.19
ARH/ARQ		0.34	–
ARH/ARH		4.47	–
ARR/VRQ	R4	0.85	–
ARQ/VRQ	R5	1.37	–

According to the results, the most widespread gene combination for ewes (39.42 %) and breeding rams (45.24 %) included in the Latvian darkhead breed genetic resource program was ARR/ARQ (R2 risk group). The study about the Latvian darkhead sheep breed by K. Grāve indicated that the most widespread scrapie genotype was ARR/ARQ (49.2 %) [6]. Gene combination ARR/ARR of the resistant group (R1) was found only in 20.48 % of sheep and 23.42 % of breeding rams included in the genetic resource program. The most common combination in R3 risk group from the analysed Latvian darkhead ewes (27.99 %) and breeding rams (26.19 %) was ARQ/ARQ.

It is important in future perspective to find out what scrapie genotype ewes and breeding rams are left for flock breeding, so that sheep breeders who have signed the contract about the reproduction of the breeding material, and conservation within the framework of genetic quality conservation program could develop classical scrapie resistant flocks.

We divided Latvian darkhead genetic resource sheep into the respective risk groups taking into consideration their birth year (Table 4).

The sheep born in 2002 and 2003 were not included in the reflection of further results due to insufficient number.

Birth year	Risk groups					Number of ewes
	R1	R2	R3	R4	R5	
2004	16.67	58.3	25.0	–	–	12
2005	9.38	34.4	53.1	3.1	–	32
2006	17.65	41.2	32.4	–	8.8	34
2007	24.00	41.3	33.3	1.3	–	75
2008	21.71	44.2	34.1	–	–	129
2009	21.28	50.0	22.3	3.2	3.2	94
2010	18.85	43.4	37.7	–	–	122
2011	8.33	50.0	41.7	–	–	36
2012	40.48	38.1	16.7	–	4.8	42

According to the results, the proportion of Latvian darkhead genetic resource sheep included in R1 risk group has increased from 16.67 % (in 2004) to 40.48 % (in 2012) and that is an increase by 41 %. The decrease in the proportion of R2 and R3 risk group sheep can be evaluated as a positive trend; the number of sheep has decreased from 42.9 % in 2003 to 38.1 % or by 12.1 % and from 57.1 % in 2003 to 16.7 % or by 29.2 %. The dominance of R4 and R5 risk group sheep is rarely met on farms engaged in Latvian darkhead sheep genetic resource program. This can be explained by the fact that farmers in Latvia started to pay attention to breeding animal scrapie genotype and choose sheep from parents having the scrapie resistant genotype determined.

Latvian darkhead genetic resource breeding rams have been divided into the respective risk groups taking into consideration their birth year (Table 5).

The rams born from 2002 to 2008 were not included in the reflection of further results due to insufficient number.

Birth year	Risk groups			Number of rams
	R1	R2	R3	
2009	25.0	33.3	41.7	12
2010	12.5	62.5	25.0	8
2011	16.7	66.7	16.7	6
2012	57.1	28.6	14.3	7

According to the results, the proportion of Latvian darkhead genetic resource rams included in R1 risk group has increased from 25 % (in 2009) to 57.1 % (in 2012) and that is an increase by 43.8 %. The decrease in the proportion of R2 risk group breeding rams can be evaluated as a positive trend; the number of breeding rams has decreased from 33.3 % in 2009 to 28.6 % or by 16.4 % and in R3 risk group the number of breeding rams decreased from 41.7 % in 2009 to 14.3 % or by 34.3 %. The dominance of R4 and R5 risk group breeding rams is not observed on farms engaged in Latvian darkhead breed genetic resource program. This can be explained by the fact that farmers use mainly R1 resistant group breeding rams for the purposes of Latvian darkhead genetic resource population breeding.

CONCLUSIONS

1. 44 % of the Latvian darkhead genetic resource sheep included in the study were put in R2 risk group but resistant sheep (R1) equalled to 21 % totalling to 65 % of sheep which can be safely used for flock breeding. Similar situation can be observed in case of Latvian darkhead breeding rams included in the genetic resource program where 48 % were put into R2 risk group but resistant breed rams accounted for 24 %.
2. The most widespread gene combination for ewes (39.42 %) and breeding rams (45.24 %) included in the Latvian darkhead breed genetic resource program was ARR/ARQ (R2 risk group). The gene combination ARR/ARR of the resistant group (R1) was found in 20.48 % of sheep and 23.42 % of breeding rams of the Latvian darkhead sheep breed included in the genetic resource program.
3. The number of Latvian darkhead genetic resource sheep having the desirable scrapie genotype (R1 and R2) and the number of sheep having the undesirable (R3–R5) scrapie genotype has decreased in flocks during 10 years. The number of breeding rams included in the Latvian darkhead breed genetic resource program has increased during 4 years in R1 risk group, while the number of animals included R2 and R3 risk group has decreased. R4 and R5 risk groups have not been observed for breeding rams during the recent years.

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LETTISCH DUNKEL KOPF SCHAFZUCHT GENETISCHEN RESSOURCEN SCRAPIE GENOTYP ANALYSE

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ZUSAMMENFASSUNG

In Lettland wird das Programm „Zur Erhaltung genetischer Ressourcen des Viehbestands“ von in Lettland gezüchteten lokalen Rassen verwirklicht, in dem auch die Rasse des lettischen dunkelköpfigen Schafs eingeschlossen worden ist.

In den letzten 5 Jahren ist die Realisierung des Programms zur Erhaltung der Rasse des lettischen dunkelköpfigen Schafs erfolgreich gewesen. Das Interesse, die reinrassigen Schafsböcke zur Zucht zu verwenden, hat zugenommen. Dadurch ist man zu genetisch gleichmäßigen Flocksen gekommen.

Das Ziel der Erhaltung der Rasse des lettischen dunkelköpfigen Schafs ist, ein Teil von den Tieren dieser Rasse als Genreserve zu erhalten, ohne die Zufuhr des fremdrassigen Blutes in den nächsten Generationen. Die lettischen dunkelköpfigen Schafe als Mutterrasse bei der Kreuzung zu verwenden, weil sie sich durch eine gute Fruchtbarkeit, Milchergiebigkeit, gute Eigenschaften als Mutterschaf, kräftige Konstitution, Krankheitswiderstand, örtliche Eignung auszeichnet. Alle genannten Merkmale sind sehr bedeutsam und diese werden die Züchter auch in der Zukunft verwenden können.

Der Verein „Verband lettischer Schafszüchter“ hat in der Zusammenarbeit mit dem deutschen Partner, dem Labor EUROFINS Medigenomix in den Jahren 2012 und 2013 durch Blutproben die Genotypen der klassischen Scrapie Krankheit bei 586 Mutterschafen und 42 Zuchtböcken der Rasse des lettischen dunkelköpfigen Schafs von 25 in Lettland existierenden Zuchtbetrieben festgestellt.

Von den tiergenetischen Ressourcen der Rasse des lettischen dunkelköpfigen Schafs, die in der Forschung eingeschlossen worden waren, ließen sich in der Risikogruppe R1 21 % der Mutterschafe und 24 % der Zuchtböcke, aber in der Risikogruppe R2 entsprechend 44 % der Mutterschafe und 48 % der Zuchtböcke einteilen, die die Züchter sicher zur Reproduktion des Zuchtflockses verwenden können.

Keywords: scrapie, genetischer ressourcen, schaf rasse, genotyp, resistenz

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IMPROVEMENT OF REPRODUCTIVE EFFICIENCY IN SOHAGI EWES USING DIFFERENT HORMONES

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ABSTRACT

The objective of this study was to compare the effects of GnRH, prostaglandin F₂α (PGF₂α) and oxytocin treatments at the time of natural mating on the conception rate (CR) of non-lactating multiparous ewes, where estrus was detected visually. All ewes (n = 56) were served naturally by fertile rams every 12 hours after the beginning of estrus. After natural mating, ewes were alternately assigned to four treatment groups treated as: (G1) PGF₂α (n = 12); (G2) GnRH (n = 12); (G3) oxytocin (n = 12) and (G4) control (n = 20). Pregnancy diagnosis was performed 25 days post-insemination by transrectal ultrasonography.

The pregnancy rate was higher ($P < 0.05$) for all the treatment groups (69.33 %) compared with G4 (55.54 %). The litter size did not differ between the groups except for the oxytocin group. Ewe lambs dominate male in this study and the sex ratio unexpectedly preferred them. Total antioxidants did not differ significantly between the groups in the present study but they were at their lowest values during the estrus in all the studied groups. It could be concluded that treatments with GnRH and PGF₂α and oxytocin at the time of service could improve conception rate.

Keywords: *Sohagi, ewe, pregnancy, antioxidants, hormones*

INTRODUCTION

Many attempts have been done to increase fertility in ewes. Gonadotropin-releasing hormone (GnRH) and its analogues administered at the time of AI are the most common treatments in management programmers for sheep flocks [6, 18]. Improvement

of the conception following GnRH treatment has been attributed to the prevention of an ovulation failure or a reduced variation in the interval between the onset of estrus and ovulation [13]. However, the results are controversial after GnRH treatment in lactating cows. Many previous works reported that conception rate in cows was improved [13], while others reported no effect on pregnancy rate [6, 20]. Oxytocin and prostaglandins have been shown as an essential parts of ovulation process [2, 19] which increase uterine and oviduct contractility [11] and affect the sperm transport. There are few studies focused on the effect of PGF administration at the time of AI on pregnancy [19]. Oxytocin was used to increase conception rate by improving the sperm transport in the female reproductive tract of several animal species [14, 22, 24]. Clitoral massage which probably releases oxytocin following artificial insemination increased pregnancy in beef cows [7]. The administration of oxytocin following AI also increased the conception rate (CR) in lactating dairy cows [24] but in another study it had any effect on the pregnancy in cows [12].

The objective of the present study was to study the effect of different hormonal treatments used to improve the reproductive efficiency in ewes on different reproductive parameters and antioxidant profiles after natural mating in subtropics.

MATERIALS AND METHODS

This work was carried out at the Animal Production Experimental Farm, Animal and Poultry Production Department, Faculty of Agriculture, Sohag University, Egypt (latitude 28°07'N and 30°33'E)

Animals and Management. This study was performed on fifty six Sohagi ewes, healthy, multiparous, non parturient and non lactating, kept away from rams before the beginning of the study, housed in semi-open pens. Water was made available all the time, and the ewes were fed on a concentrate mixture with wheat straw and green fodder, providing 14 % crude protein and 70 % total digestible nutrients during the experimental period. Feeding and management factors were the same for all ewes throughout the studied period. The experiment was carried out during January breeding season.

Estrus was detected using well trained ram teasers and personnel, and ewes were mated using hand mating with fertile rams every 12 hours till the end of estrus. Immediately after the last mating, animal were assigned into four groups: G1 (n = 12) received intra muscular injection of 15 mg of Dinoprost (PGF₂α Lutalyse, Pharmacia & Upjohn, NY); G2 (n = 12) received 25 ug intra muscular Gonadorelin (GnRH) (Factrel, Fort Dodge, IA, USA); G3 (n = 12) treated with intra muscular injection of oxytocin (Bimeda-MTC Animal Health Inc., Cambridge, Ontario, Canada) and G4 (control group, n = 20) received intra muscular 5 ml normal saline.

The blood samples were collected from animals beginning on day 0 (day of treatment) and every 10 days till day 50 post mating. Serum was separated and stored at -20°C till assayed for total antioxidants. Pregnancy was diagnosed on Day 25 post ma-

ting for all animals using a real-time, B-mode echocamera (EUB-05B, Hitachi, Tokyo, Japan) attached with a 5–7.5 MHz transducer. Visualization of a fluid-filled uterine horn with embryonic vesicles and the presence of an embryo were used as positive indications of pregnancy. The pregnancy rate was calculated as the number of ewes diagnosed pregnant divided by the number of mated ewes.

Serum total antioxidants status. The total antioxidant status in the serum samples were measured using Total Antioxidant Capacity (TAC) Assay Kit (K274-100 BioVision, Inc. Headquarters, 155 South Milpitas Blvd., Milpitas, California 95035).

Statistical analyses. All statistical procedures were performed using the computational software of SAS (2001).

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where:

Y_{ij} = observations

μ = general mean

T_i = the effect due to the treatment.

e_{ij} = error.

Chi-square analysis using the PROC FREQ procedure was used to compare the pregnancy rate among the treatment groups. The differences among means were tested according to Duncan [5].

RESULTS AND DISCUSSION

The pregnancy rate detected on days 25 were higher ($P < 0.05$) in all the treatment groups compared with G4. However, the pregnancy rate did not differ significantly among G1, G2 and G3. Gestation length, ewes' weight at birth, the weight did not differ significantly among the experimental groups (Table 1).

Table 1. Effect of hormonal treatment on reproductive parameters of Sohagi ewes							
Treatment	Gestation length	Ewe body weight	Birth weight	Pregnancy rate %	Twining %	Triplets %	Litter size
PGF ₂ α	154.1 $\pm$ 7.34	36.3 $\pm$ 3.42	3.5 $\pm$ 0.23	71 ^a	14.28	----	1.2
GnRH	157.13 $\pm$ 8.79	36.12 $\pm$ 5.96	3.71 $\pm$ 0.41	66 ^a	25.00	----	1.37
Oxytocin	153.7 $\pm$ 6.32	38 $\pm$ 9.54	3.29 $\pm$ 0.52	71 ^a	26.66	6.66	1.66
Control	152.44 $\pm$ 0.84	38.29 $\pm$ 7.67	3.56 $\pm$ 0.43	55.54 ^b	40.00	5.00	1.23
a and b value with different superscript letters are significantly different within the same column $p < 0.05$							

Total antioxidants did not differ significantly between the groups by day of gestation. However, a significant difference was observed in different periods of gestation (Table 2).

Table 2. Effect of hormonal treatment on total antioxidant capacity in blood serum of Sohagi ewe				
Days after mating	PGF ₂ α	GnRH	Oxytocin	Control
0	0.31 $\pm$ 0.01 ^a	0.32 $\pm$ 0.01 ^a	0.25 $\pm$ 0.01 ^a	0.11 $\pm$ 0.02 ^a
10	4.23 $\pm$ 0.01 ^b	4.04 $\pm$ 0.91 ^b	5.58 $\pm$ 0.6 ^b	3.22 $\pm$ 0.12 ^b
20	4.29 $\pm$ 0.45 ^b	5.18 $\pm$ 0.37 ^b	5.27 $\pm$ 0.59 ^b	4.38 $\pm$ 1.09 ^b
30	5.09 $\pm$ 0.56 ^b	4.66 $\pm$ 0.45 ^b	4.40 $\pm$ 0.51 ^b	6.23 $\pm$ 0.87 ^b
40	4.99 $\pm$ 0.36 ^b	5.22 $\pm$ 0.31 ^b	5.36 $\pm$ 0.75 ^b	4.91 $\pm$ 1.20 ^b
50	7.36 $\pm$ 0.42 ^c	7.06 $\pm$ 0.93 ^c	6.84 $\pm$ 0.74 ^c	8.34 $\pm$ 1.65 ^c
a, b, c value with different superscript letters are significantly different within the same column p < 0.05				

With regard to pregnancy rate, the reproductive performance of sheep in the present study improved significantly in the treated ewes compared with the non treated control ones and notably oxytocin treatment had a positive effect on the litter size. However, birth weight, gestation length and sex ratio as well as total antioxidants did not undergo any changes.

The present results of lambing rate in the treated groups come close to the results of Beck *et al.* (1994) who found that treatment with GnRH analogue on Day 12 post-mating increased lambing rates and litter size in ewes [4]. The results obtained on cattle also showed that treatment with GnRH improved pregnancy rate by 7–21 % [13]. This comes in inconsistency with other studies indicating that pregnancy rate was not affected by GnRH treatment following AI [6, 20]. Variability in pregnancy rate among the different studies might be associated with the effect of GnRH on gonadotropin release [23] or the timing of GnRH and mating relative to the onset of estrus. Earlier studies showed that the timing of GnRH injection according to the onset of estrus affected gonadotropin release. Although exogenous GnRH at the onset of estrus increased the pre-ovulatory LH surge [13, 20], conception rate increase was reported only in one study [13] but not in others [20]. However, the administration of GnRH at the time of AI, approximately 12 h after the initiation of standing estrus, did not result in a greater surge of LH [16]. In addition, the insufficient LH surge did not have any ovulatory effect [13, 16] and did not improve pregnancy.

The present results indicated that administration of PGF at the time of AI following spontaneous estrus have a beneficial effect on pregnancy rate. Few studies showing the effect of oxytocin on pregnancy rate in sheep at the time of AI were published [12, 24]. Bekeova *et al.* (1995) indicated that oxytocin, GnRH treatments affected conception rate in post partum ewes through increasing the level of thyroxin, triiodothyronine, oestradiol 17 β and progesterone and suggested that the causes of depression of T₄ and T₃ levels after parturition in spring might be due to lack of gonadotropins [5]. Low concentration of T₄ and T₃ in certain phases of the post-partum period might be retroactively responsible for the decline in post-partum sexual activity in ewes. However, the study of Yildiz (2005) indicated that the pregnancy rate increased in lactating dairy cows after oxytocin

administration just before AI, what is in agreement with the present findings [24]. This could be due to changes in uterine contractility and possibly to the acceleration of sperm transport in the reproductive tract of ewes [11, 14, 22]. Oxytocin possibly exerted its influence by stimulating prostaglandin production [15, 17]. In addition to involuntary effects upon the uterus [10], prostaglandins may have acted as LH-stimulating [1] and estrogen-stimulating factors [9].

Although there were no significant differences among the experimental groups regarding the level of total antioxidant but it was worthy note that the level of these elements had gradually increased throughout the early pregnancy period towards the end of the first trimester of the studied ewes. The changes in the antioxidant enzymatic defence could be a part of placentome adaptation to reactive oxygen species-induced oxidative stress at specific early developmental stages of pregnancy. Previous reports showed that the activities of antioxidant enzymes in the sheep *corpus luteum* (CL) are subject to major changes during early pregnancy, suggesting that the CL of early pregnancy may be rescued from luteolysis through increasing activities of key antioxidant enzymes and inhibition of apoptosis. Maintained levels of antioxidant enzymes in the CL throughout pregnancy may be linked to reactive oxygen species continuously generated in the luteal cells, and may be involved in the maintenance of luteal steroidogenic activity, cellular integrity and preventive to oxidative stress, improving pregnancy outcomes [3].

CONCLUSION

The results suggest that the administration of GnRH, oxytocin and PGF at the time of natural mating increased the pregnancy rate in subtropical ewes.

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NUJUNKYTŲ LIETUVOS VIETINIŲ ŠIURKŠČIAVILNIŲ ĖRIUKŲ AMŽIAUS IR SVORIO ĮTAKA TOLESNIAM AUGIMUI BEI VYSTYMUISI

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SANTRAUKA

Pagrindinis šio darbo uždavinys buvo nustatyti optimaliausių nujunkomų ėriukų amžių ir svorį bei jų įtaką tolesniam augimui iki 1 metų amžiaus. Tam tikslui išanalizavome 2007–2012 m. laikotarpiu LSMU Gyvulininkystės institute laikomų Lietuvos vietinių šiurkščiaivilnių avių veislų duomenų apskaitos žurnalus. Remdamiesi juose padarytais įrašais, išskyrėme po 3 skirtingo svorio (8–12, 12,1–16 ir 16,1–20 kg) ir amžiaus (35–55, 56–70 ir 71–90 d.) nujunkytų ėriukų grupes. Atskirai vertinome avytes ir avinukus.

Pirmą kartą atlikus tokį tyrimą nustatyta, jog 2007–2012 m. laikotarpiu instituto avių bandoje nujunkyti 209 ėriukai, iš kurių 48,32 % nujunkymo metu buvo 56–70 d., 28,71 % – 35–55 d. ir 22,97 % – 71–90 d. amžiaus. Tiek nujunkyti 35–55 d., tiek 71–90 d. iki 7 ir 12 mėn. amžiaus augo beveik vienodai. Tuo tarpu nujunkyti 56–70 d. amžiaus iki 7 mėn. augo lėčiausiai, o 7–12 mėn. laikotarpiu – greičiausiai, palyginti su 35–55 d. ir 71–90 d. amžiaus nujunkytomis ėriukais. Taigi, ėriukų amžius nujunkymo metu mažai įtakojo tolesnį jų augimą. Kur kas svarbesnis buvo nujunkomų jauniklių svoris. Kuo didesnio svorio ėriukai nujunkyti, tuo jie daugiau svėrė 7 ir 12 mėn. amžiuje. Todėl 16,1–20 kg svorio nujunkyti ėriukai 7 mėn. amžiuje turėjo 2,54–5,83 kg ($P < 0,01$ – $P < 0,001$), o 12 mėn. amžiuje – 1,54–4,63 kg ($P < 0,025$) persvarą, lyginant su 8–12 ir 12,1–16 kg svorio nujunkytomis jaunikliais.

Raktažodžiai: ėriukai, nujunkymas, ėriukų svoris, ėriukų amžius, augimas

IVADAS

Avių ūkio pelningumas labiau priklauso ne nuo avių vislumo, o nuo ėriukų išsaugojimo iki nujunkymo. Daugelyje užsienio šalių priimta, kad ėriukų išsaugojimas iki 42 d. amžiaus turi siekti 1,5 ėriuko iš vienos ėriavedės, o jauniklių prieaugis per parą turi būti 250–350 g [2, 7, 13].

Paprastai ėriukai nujunkomi 3–4 mėn. amžiaus, kuomet gali būti visus avims skirtus pašarus. Tuo tarpu pieninių veislių avių jauniklius galima atskirti nuo motinos ir 1–1,5 mėn. amžiaus. Tyrimais nustatyta, kad ėriuko svariui patrigubėjus (lyginant su ką tik atvesto ėriuko svariui), pieno jam nebereikia, tačiau jis turi sverti ne mažiau kaip 12 kg. Tokiems ėriukams jau nuo 10–12 gyvenimo dienos reikia pradėti duoti sultingų, koncentruotų, stambių ir mineralinių pašarų, kad jų skrandis prisitaikytų ląstelienos virškinimui [8, 9].

Anksčiau nei įprastai ėriukus galima nujunkyti, kai šis periodas sutampa su ganyvos pradžia. Tuomet ėriukams pakanka papildomai duoti tik koncentratų. Jei atvesti jaunikliai sveria 4–4,5 kg, tai nujunkant 1,5 mėn. amžiaus, jų svoris turėtų būti ne mažesnis kaip 8–10 kg. Beje, nujunkyti vėliau negu 4 mėn. amžiaus nerekomenduojama [7, 13, 15].

Pasaulio mokslininkai yra atlikę nemažai tyrimų su įvairių veislių skirtingo svorio ir amžiaus nujunkytais ėriukais. Pastebėta, jog didžiausias jauniklių mirtingumas būna iki 4–6 sav. amžiaus. Todėl geriausia nujunkyti 2 mėn. amžiaus sulaukusius ėriukus. Beje, nujunkomų jauniklių amžius beveik neturi įtakos tolesniam jų augimui ir svariui. Atlikti tyrimai parodė, jog tiek nujunkyti 2 mėn., tiek 4 mėn. amžiaus ėriukai bei ožkiukai iki subrendimo augo panašiai ir turėjo panašius virškinamojo trakto bei kitų tyrimų parametrus [1, 4, 5, 14].

Nemažai įvairių tyrimų yra atlikta su pieninių veislių avių jaunikliais. Kadangi pagrindinė šių avių produkcija yra pienas, todėl ieškoma efektyviausių būdų kokybiškam ėriukų išauginimui ir maksimaliam pieno realizavimui. Tyrimų autoriai pataria apsiėriavusias pienines avis melžti jau po 3 dienų, o ėriukus prileisti žįsti 9 ir 15 val. arba girdyti pienu ir laikyti gretutiniame garde. Jeigu jaunikliai gerai prižiūrimi, jie auga panašiai kaip ir 60 dienų laikyti kartu su ėriavedėmis [4, 8, 9]. Be to, siekiant išvengti didesnio streso, ėriukus reikėtų nujunkyti 2 etapais [10].

Tyrimais nustatyta, kad tolesnį jauniklių augimą nemažai įtakoja jų svoris nujunkant. Brazilijoje atlikti bandymai su Morada Nova veislės ėriukais parodė, jog geriausiai augo 10,5 kg svorio nujunkyti jaunikliai, lyginant su 9 ir 12,5 kg nujunkytais ėriukais [11]. Tuo tarpu Awassi veislės jauniklius tikslingiausia nujunkyti, kai jie sveria 15 kg [4]. Ėriukų svoris nujunkant įtakoja ne tik tolesnį jų augimą ir vystymąsi, bet ir mėsines savybes. Tai nustatė Egipto mokslininkai, ištyrę Barki veislės nujunkytus ėriukus [6].

Mūsų tyrimų tikslas – nustatyti optimaliausią nujunkomų Lietuvos vietinių šiurkščiaivilnių ėriukų amžių ir svorį bei jų įtaką tolesniam augimui.

TYRIMŲ OBJEKTAS IR METODAI

Nujunkomų ėriukų amžiaus ir svorio įtakos jų tolesniam augimui bei vystymuisi iki 1 metų amžiaus ištyrimui naudojome 2007–2012 m. LSMU Gyvulininkystės institute laikomų Lietuvos vietinių šiuurkščiavilnių avių bandos duomenis. Kadangi ši banda yra pripažinta A kategorijos avių veislynu, todėl čia vedama tiksli avių veislininkystės ir produktyvumo apskaita.

Analizei atlikti naudojome 2007–2012 m. avių kergimo, ėriavimosi ir prieauglio augimo apskaitos bei avių svorio ir vilnos produkcijos apskaitos žurnalus. Remdamiesi juose padarytais įrašais, išskyrėme po 3 skirtingo svorio (8–12, 12,1–16 ir 16,1–20 kg) ir amžiaus (35–55, 56–70 ir 71–90 d.) nujunkytų ėriukų grupes. Atskirai vertinome avytes ir avinukus.

Nustatydami, kaip augo skirtingo amžiaus ir svorio nujunkyti ėriukai, analizavome jų svorį 7 ir 12 mėn. amžiuje. Gautus duomenis įvertinome biometriškai, naudodamiesi Windows operacinės sistemos skaičiuokle Excel (2007), o patikimumo laipsnį nustatėme pagal Stjudentą. Duomenys laikomi patikimais, kai $P < 0,05$ [3, 12].

TYRIMŲ REZULTATAI IR JŲ APTARIMAS

2007–2012 m. laikotarpiu LSMU Gyvulininkystės institute laikomų Lietuvos šiuurkščiavilnių avių bandoje buvo nujunkyti 209 ėriukai. Avys buvo kergiamos spalio–lapkričio mėn., o ėriavosi kovo–balandžio mėn. Skirtingo amžiaus ir svorio jaunikliai buvo nujunkomi gegužės mėn. antroje pusėje. Jų amžius svyravo 35–90 d., o svoris – 8–20 kg ribose (1–2 lentelės).

1 lentelė. Nujunkytų ėriukų amžiaus įtaka tolesniam augimui Table 1. The effect of weaned lamb age on the subsequent growth						
Rodikliai Item	Nujunkytų ėriukų amžius, d. Age of weaned lambs, days					
	35–55		56–70		71–90	
	n	M ± m	n	M ± m	n	M ± m
Nujunkytų ėriukų svoris, kg Weight of weaned lambs, kg	60	12,96 ± 0,386 ^a	101	14,25 ± 0,333 ^b	48	15,52 ± 0,379 ^c
Iš jų: Including:						
avyčių Female lambs	36	12,80 ± 0,440 ^d	50	14,26 ± 0,427 ^e	24	14,67 ± 0,545 ^f
avinukų Male lambs	24	13,13 ± 0,742 ^g	51	14,34 ± 0,513 ^h	24	16,35 ± 0,477 ⁱ

1 lentelė. (Tęsinys) Table 1. (Continued)						
7 mėn. ėriukų svoris, kg Weight of lambs at 7 months of age, kg	60	30,02 ± 0,844	100	28,99 ± 0,594	48	30,33 ± 0,634
Iš jų: Including:						
avyčių Female lambs	36	28,57 ± 0,938	51	27,51 ± 0,816	24	28,88 ± 0,674
avinukų Male lambs	24	31,83 ± 1,474	49	30,46 ± 0,835	24	31,87 ± 0,967
12 mėn. ėriukų svoris kg Weight of lambs at 12 months of age, kg	23	39,58 ± 1,696 ^j	73	44,44 ± 0,820 ^k	40	39,71 ± 1,263 ^l
Iš jų: Including:						
avyčių Female lambs	14	38,05 ± 1,638	32	41,60 ± 1,042 ^m	21	36,63 ± 0,981 ⁿ
avinukų Male lambs	9	41,98 ± 3,507	41	46,71 ± 1,101	19	43,11 ± 2,206
(d,e)(j,k)P < 0,025; (a,b)(b,c)(d,f)P < 0,01; (h,i)(k,l)P < 0,005; (a,c)(g,i)(m,n)P < 0,001.						

1 lentelėje pateikti duomenys rodo, kad 48,32 % ėriukų nujunkymo metu buvo 56–70 d., 28,71 % – 35–55 d. ir 22,97 % – 71–90 d. amžiaus. Visiškai natūralu, jog vyresnio amžiaus nujunkyti jaunikliai svėrė 1,27–2,56 kg daugiau negu nujunkyti jaunesniame amžiuje. Tuo tarpu avyčių grupėje šie skirtumai svyravo 0,41–1,87 kg, o avinukų – 1,21–3,22 kg ribose. Visi minėti skirtumai statistiškai patikimi.

Analizuojant 7 mėn. amžiaus sulaukusių ėriukų svorį nustatyta, kad mažiausiai svėrė 56–70 d. amžiaus nujunkyti ėriukai. Palyginti su 35–55 d. amžiaus nujunkytiais jaunikliais, jie svėrė 1,03 kg mažiau, o su 71–90 d. amžiaus nujunkytiais ėriukais – 1,34 kg. Tuo tarpu nujunkyti 35–55 d. ir 71–90 d. jaunikliai iki 7 mėn. amžiaus augo beveik vienodai. Todėl jų svoris šiame amžiuje skyrėsi tik 0,31 kg. Visi minėti skirtumai statistiškai nepatikimi.

Analizuojant metinių jauniklių svorį nustatyta, kad 7–12 mėn. laikotarpiu greičiausiai augo 56–70 d. amžiaus nujunkyti ėriukai (lėčiausiai augę iki 7 mėn. amžiaus). Palyginti su 35–55 d. amžiaus nujunkytiais ėriukais, jie svėrė 4,86 kg ($P < 0,025$) daugiau, o su 71–90 d. nujunkytiais jaunikliais – 4,73 kg ($P < 0,005$) daugiau. Tuo tarpu nujunkyti 35–55 d. ir 71–90 d. ėriukai 7–12 mėn. laikotarpiu augo beveik vienodai. Todėl jų svoris šiame amžiuje skyrėsi nežymiai (avyčių – 1,42 kg, o avinukų – 1,13 kg). Skirtumai statistiškai nepatikimi.

Analizės rezultatai rodo, jog ėriukų amžius nujunkymo metu mažai įtakoja tolesnį jų augimą. Panašiai teigia ir įvairiose šalyse tokius tyrimus atlikę mokslininkai. Kur kas svarbesnis yra nujunkomų ėriukų svoris.

2 lentelė. Nujunkytų ėriukų svorio įtaka tolesniam augimui

Table 2. The effect of weaned lamb weight on the subsequent growth

Rodikliai Item	Nujunkytų ėriukų svoris kg Weight of weaned lambs, kg					
	8–12		12,1–16		16,1–20	
	n	M ± m	n	M ± m	n	M ± m
7 mėn. ėriukų svoris kg Weight of lambs at 7 months of age, kg	55	26,51 ± 0,629 ^a	98	29,80 ± 0,556 ^b	55	32,34 ± 0,802 ^c
Iš jų: Including:						
avyčių Female lambs	29	26,12 ± 0,875 ^d	59	28,11 ± 0,637 ^e	22	31,40 ± 1,149 ^f
avinukų Male lambs	26	27,30 ± 0,881 ^g	39	32,37 ± 0,873 ^h	33	33,28 ± 1,047 ⁱ
12 mėn. ėriukų svoris kg Weight of lambs at 12 months of age, kg	43	39,86 ± 0,998 ^j	63	42,95 ± 0,944 ^k	30	44,49 ± 1,731 ^l
Iš jų: Including:						
avyčių Female lambs	21	38,62 ± 1,334	35	38,83 ± 0,964	12	41,43 ± 1,706
avinukų Male lambs	22	41,01 ± 1,467 ^m	28	48,24 ± 1,152 ⁿ	18	45,08 ± 2,513
(e,f)(j,k)(j,l))P < 0,025; (b,c)P < 0,01; (a,b)(a,c)(d,f)(g,h)(g,i)(m,n)P < 0,001.						

Iš 2 lentelėje esančių duomenų matyti, jog iki 7 mėn. amžiaus greičiausiai augo 16,1–20 kg svorio nujunkyti ėriukai. Palyginti su 12,1–16 kg svorio nujunkytais jaunikliais, jie buvo sunkesni 2,54 kg ($P < 0,01$), o su 8–12 kg svorio nujunkytais ėriukais – 5,83 kg ($P < 0,001$). Tuo tarpu 7–12 mėn. laikotarpiu intensyviausiai augo 12,1–16 kg svorio nujunkyti avinukai. Todėl 12 mėn. amžiuje jie turėjo 7,23 kg persvarą, lyginant su 8–12 kg svorio nujunkytais avinukais ($P < 0,001$), ir buvo 3,16 kg sunkesni negu 16,1–20 kg svorio nujunkyti jaunikliai. Beje, 12 mėn. amžiaus avyčių svorio skirtumas buvo 0,21–2,81 kg ir statistiškai nepatikimas.

Apibendrinant galima teigti, kad nujunkomų ėriukų svoris įtakoja jų augimą bei vystymąsi. Kuo daugiau ėriukai sveria nujunkant, tuo jie greičiau auga iki 7 mėn. ar 1 metų amžiaus. Tą patvirtina ir kitų mokslininkų atlikti tyrimai.

IŠVADOS

1. Tyrimu nustatyta, kad ėriukų amžius nujunkymo metu mažai įtakojo tolesnį jų augimą.
2. Nujunkomų ėriukų svoris yra tiesiogiai proporcingas jų tolesniam augimui. Kuo didesnio svorio jaunikliai nujunkomi, tuo daugiau jie sveria 7 ar 12 mėn. amžiuje.
3. Optimaliausias nujunkomų Lietuvos vietinių šurkščiavilnių ėriukų amžius yra 60 dienų, o svoris – apie 16 kg.

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THE EFFECT OF AGE AND WEIGHT OF WEANED LITHUANIAN NATIVE COARSEWOOLED LAMBS ON SUBSEQUENT GROWTH AND DEVELOPMENT

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SUMMARY

The purpose of this study was to determine the optimum age and weight of weaning lambs and the influence of these factors on the subsequent growth till one year of age. The recorded data for the period from 2007 to 2012 have been analyzed regarding the breeding centre of Lithuanian coarsewooled sheep established at the LHSU Institute of Animal Science. Three groups of weaned lambs of different weight (8–12, 12.1–16 and 16.1–20 kg) have been analyzed. Female and male lambs were analyzed separately.

The study indicated that in the period from 2007 to 2012, 209 lambs were weaned at the age of 56–70 days (48.32 %), 35–55 days (28.71 %) and 71–90 days (22.97 %). The growth of lambs till 7 and 12 months was the same despite weaning at either 35–55 or 71–90 days. Whereas the lambs weaned at 56–70 days had the lowest weight gains till 7 months age and the highest gains from 7 to 12 months of age in comparison with those weaned at 35–55 and 71–90 days of age. Thus, the influence of age on the subsequent growth of lambs was insignificant. The weight of weaned lambs was more important. The higher was the weight of weaned lambs, the higher was the weight at the age of 7 and 12 months. Thus, the weaning lambs of 16.1–20 kg weight exceeded in weight the lambs that were weaned of 8–12 and 12.1–16 kg weight by 2.54–5.83 kg ($P < 0.01$ – $P < 0.001$) and 1.54–4.63 kg ($P < 0.025$) at the age of 7 and 12 months, respectively.

Keywords: lambs, weaning, age, weight, growth

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ВЛИЯНИЕ ВОЗРАСТА И ВЕСА ОТЪЕМНЫХ ЛИТОВСКИХ МЕСТНЫХ ГРУБОШЕРСТНЫХ ЯГНЯТ НА ДАЛЬНЕЙШИЙ РОСТ И РАЗВИТИЕ

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РЕЗЮМЕ

Основная задача этой работы – установить оптимальный возраст и живой вес отъемных ягнят и влияние их на дальнейший рост животных до годовалого возраста. Для этой цели проанализировали данные племзавода литовских местных грубошерстных овец, содержащихся в Институте животноводства ЛУНЗ в период 2007–2012 г. По записям в журналах отъемные ягнята разделили на 3 группы по весу (8–12, 12,1–16 и 16,1–20 кг) и возрасту (35–55, 56–70 и 71–90 дней). Отдельно исследовали ярочек и баранчиков.

Первый раз проведен такой опыт показал, что в периоде с 2007 до 2012 г. в стаде овец Института было отлучено 209 ягнят, из которых 48,32 % были 56–70 дней, 28,71 % – 35–55 дней и 22,97 % – 71–90 дней возраста. Ягнята, которые при отъеме имели 35–55 дней и 71–90 дней, до 7- и 12-месячного возраста росли почти одинокого. Но ягнята, отлучены в 56–70-дневном возрасте, до 7 мес. различались самым медленным ростом, а в периоде с 7 до 12 мес. – самым скорым ростом по сравнению с ягнятами, отлученными в 35–55 и 71–90-дневном возрасте. Так, что возраст ягнят при отъеме мало влиял на дальнейший рост животных. Однако живой вес отъемных ягнят оказался более важным. Чем больше ягнята весили при отъеме, тем скорее росли до 7 и 12-месячного возраста. Поэтому 16,1–20 кг веса отъемные ягнята в 7-месячном возрасте были на 2,54–5,83 кг ($P < 0,01$ – $P < 0,001$), а в 12-месячном возрасте – на 1,54–4,63 кг ($P < 0,025$) тяжелее, чем 8–12 и 12,1–16 кг веса отъемные ягнята.

Ключевые слова: ягнята, отъем, живая масса, возраст, рост

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TRIS KARTUS MELŽIAMŲ, At METODU KONTROLIUOJAMŲ KARVIŲ PRODUKTYVUMO APSKAITOS BŪDŲ PALYGINIMAS

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SANTRAUKA

Tris kartus melžiamų karvių produktyvumo kontrolę tvarkant At būdu, apskaitos paklaidos gali siekti 18–20 %. Apskaitos tikslumą galima didinti, pasirenkant sudėtingesnes vieno paros melžimo duomenų perskaičiavimo schemas arba didinant perskaičiavimo koeficientų nustatymui reikalingų eksperimentų apimtį, ar pasitelkiant didesnes statistinių duomenų bazes. Visi šie būdai reikalauja papildomų finansinių ir darbo sąnaudų. Todėl aktualu rasti optimalų santykį tarp pasirenkamos apskaitos sistemos ir tenkinančio tikslumo.

Straipsnyje, apibendrinus daugiau kaip tūkstančio vienos bandos Lietuvos juodmargių karvių, melžiamų tris kartus per parą, kontrolinių melžimų duomenis, palyginti du produktyvumo rodiklių perskaičiavimo metodai ir jų praktinio taikymo galimybės: kai naudojama koeficientų sistema ir kai duomenys dauginami iš 3.

Nustatyta, kad naudojant koeficientų sistemą, paros primilžis iš vieno melžimo duomenų buvo apskaičiuojamas su ne didesne kaip 2,3 %, riebalų kiekis – su ne didesne kaip 10,6 % ir baltymų kiekis – su ne didesne kaip 2,2 % paklaida. Vieno melžimo duomenis dauginant iš 3, paros primilžio paklaidos buvo 3,3–8,2 karto, baltymų kiekio – 4,0–8,3 karto didesnės. Riebalų kiekio, perskaičiuoto iš dieninio ir vakarinio melžimo duomenų, buvo atitinkamai 8,3 % ir 1,5 karto didesnės, negu naudojant koeficientų sistemą. Tačiau rytinio melžimo duomenis dauginant iš 3, paros riebalų kiekis apskaičiuotas 7,7 kartus tiksliau.

Remiantis tyrimo rezultatais teigiama, kad karvių kontrolinių melžimų apskaitai tikslinga taikyti koeficientų sistemą, kada koeficientai periodiškai tikslinami net ir nedidelės apimtys eksperimentais. Vieno melžimo duomenų dauginimo iš 3 būdas gali būti pateisinamas tik perskaičiuojant paros riebalų kiekį.

Raktažodžiai: karvių produktyvumo kontrolė, At metodas, trijų kartų melžimas

IVADAS

Tiksli produktyvumo apskaita lemia sėkmingą galvijų selekcijos procesą. Tai būtina priemonė gerinant bandos sudėtį, produktyvumo ir sveikatingumo rodiklius, didinant pieno gamybos efektyvumą, ūkių stiprėjimą. Taip pat tai yra prioritetinės reikšmės priemonė investicijų požiūriu, nuosekliai plėtojant nacionalinę veislininkystę ir siekiant lygiavertės partnerystės su kitomis šalimis.

Karvių produktyvumo kontrolei naudojami skirtingi produktyvumo apskaitos metodai [1, 3, 12, 15]. Vienu iš ekonomiškesnių laikomas At metodas, kai fiksuojami tik vieno paros melžimo duomenys ir intervalas tarp dviejų paskutinių melžimų, o produktyvumas per parą apskaičiuojamas naudojant statistiškai nustatytus, periodiškai koreguojamus koeficientus. Nustatyta, kad naudojant šį metodą, išlaidos produktyvumo kontrolei atlikti yra 20–25 % mažesnės negu atliekant kontrolę, kai fiksuojami visi paros melžimai [12]. Šį metodą oficialiai aprobavo Tarptautinis gyvulių apskaitos komitetas (International Committee for Animal Recording – ICAR), jį naudoja dauguma šalių [4]. Be to, tai vienas iš tiksliausių produktyvumo apskaitos metodų, tikslesnis tik A4 metodas, kai kas mėnesį fiksuojami visi paros melžimų duomenys [11]. Tačiau japonų mokslininkai, išanalizavę duomenų bazę, sudarytą iš daugiau kaip 23 milijonų įrašų, pažymi, kad naudojant At metodą, bendras pieno ir jo komponentų paros produktyvumas tiksliau apskaičiuojamas iš rytinio, o ne iš vakarinio kontrolinio melžimo duomenų [5].

Įvairių melžimo schemų apskaičiuotų produktyvumo duomenų tikslumą pirmą kartą statistiškai įvertinti pabandė McDaniel 1969 metais [9]. Lyginant apskaičiuotų ir realiai gautų duomenų standartines deviacijas, buvo atkreiptas dėmesys į būtinybę naudoti perskaičiavimo koeficientus, apskaičiuojant paros produktyvumą iš vieno melžimo duomenų bei atsižvelgti į intervalus tarp melžimų. Naudojant šiandien efektyviausią matricių algebros metodą, teoriškai nustatyta skaičiavimo paklaidos kitimo priklausomybė nuo paros melžimų registravimo skaičiaus ir naudojamos melžimo schemas [14].

Nustatyta, kad jeigu paros produktyvumas apskaičiuojamas vieno iš dviejų paros melžimo duomenis dauginant iš dviejų, tai automatiškai gaunama vidutiniškai 5 % metodinė paklaida [2]. Slovėnijoje atliktais tyrimais įrodyta, kad baltymų kiekį apskaičiuoti iš At metodu kontroliuojamų karvių duomenų galima žymiai tiksliau (apskaičiuoto baltymų kiekio koreliacijos su realiu kiekiu koeficientas – iki 0,987), negu riebalų (koreliacijos koeficientas – ne didesnis kaip 0,578). Be to, sudėtingesni skaičiavimo modeliai leidžia sumažinti tik ekstremalių reikšmių paklaidas [6].

Produktyvumui apskaičiuoti naudojant vieno iš paros kontrolinio melžimo duomenis, Kanados mokslininkai pasiūlė atsižvelgti net į 72 poklasių, į kuriuos pagal laktacijos trukmę, veršingumo laikotarpį bei veršiamosios sezoną būtų galima suskirstyti karves, kontroliuojamas pagal vieną iš 18 galimų trijų per parą melžimų bei vieną iš 4 galimų dviejų per parą melžimo schemų [13]. Tačiau jų sudarytos lygtys tik šiek tiek tiksliau leido apskaičiuoti visos dienos produkciją negu naudojant oficialius koeficien-

tus: esant dviejų per parą melžimų schemai, riebalų kiekis buvo apskaičiuojamas 12 % tikslumu iš vakarinio ir 11 % – iš rytinio melžimo; jeigu apskaitomi tik vieno melžimo duomenys, esant trijų per parą melžimų schemai, tai riebalų ir baltymų kiekis per parą buvo apskaičiuojamas tik 18–20 % tikslumu. Jie perspėja, kad naudojant trijų melžimų per parą schemą, būtina kontroliuoti bent dviejų melžimų produkcijos duomenis, tuomet tikslumas padidėtų iki 6–9 %.

Atkreipiamas dėmesys į tai, kad dėl būdingų santykinai didelių duomenų dispersijų, daugiausia darbo laiko sąnaudų reikalauja riebalų kiekio statistinių rodiklių nustatymas [8]. Vokietijoje atliktais tyrimais įrodyta, kad, kokį skaičiavimo modelį benaudotume, karvių, kontroliuojamų At metodu, produktyvumas tiksliau įvertinamas iš rytinio melžimo duomenų negu iš vakarinio. Be to, didžiausios paklaidos gautos, skaičiuojant riebalų kiekį iš vieno melžimo duomenų, naudojant trijų per parą melžimų schemą [7].

ICAR inicijuotos darbo grupės duomenimis, 29 (iš 38 apklaustų) šalyse naudojamos specifinės formulės arba atitinkami koeficientai produkcijai iš vieno melžimo duomenų apskaičiuoti, atsižvelgiant į klimatinės sąlygas, karvių veislę, santykį tarp apskaitai skiriamų lėšų bei nacionalinę veislininkystės sistemą tenkinančio tikslumo ir kt. Tačiau kai kuriose šalyse, pavyzdžiui, Prancūzijoje ir Lenkijoje, paros produktyvumas apskaičiuojamas, paprasčiausiai vieno melžimo duomenis dauginant iš melžimų per parą skaičiaus [10]. Todėl manoma, kad būtina sukurti metodus, leisiančius suvienodinti paros produkcijos, nustatytos įvairiais būdais, apskaitą.

Tris kartus per parą melžiamų karvių skaičius Lietuvoje nėra didelis – tik apie 1,5 %. Todėl gana sunku organizuoti reikiamos apimties tyrimus produktyvumo rodiklių perskaičiavimo koeficientams nustatyti. Dar sudėtingiau įvertinti įvairių zootechninių ir ūkinių faktorių įtaką koeficientams. Tokiu atveju aktualu rasti kompromisą tarp skaičiavimo metodo sudėtingumo ir tenkinančio tikslumo.

Šio darbo tikslas – palyginti du karvių, melžiamų tris kartus per parą, produktyvumo rodiklių perskaičiavimo iš vieno paros melžimo duomenų būdus ir jų praktinio taikymo galimybes, kai naudojama koeficientų sistema ir kai duomenys dauginami iš 3.

TYRIMŲ SĄLYGOS IR METODAI

Tyrimai vykdyti 2012–2013 metais Lietuvos sveikatos universiteto Gyvulininkystės institute bei žemės ūkio bendrovėje „Draugas“ (Radviliškio r.).

Tyrimui pasirinktoje žemės ūkio bendrovėje „Draugas“ laikomos žaliųjų ir žalmargių veislių karvės, melžiamos tris kartus per parą ir iš kurių vidutiniškai per paskutinę laktaciją primelžta 9169 kg pieno. Parenkant karves moksliniams-gamybiniais bandymams, atsižvelgta į jų veterinarinę būklę, veislę, amžių, laktaciją, laktacijos stadiją, veršiamosi ir užtrūkimo laikotarpius, produktyvumo lygį, melžimo tvarką. Karvės buvo melžiamos De Laval (Švedija) melžimo aikštelėje. Kiekvieno melžimo metu buvo

imamas individualus pieno mėginys, o primilžiai registruojami ALPRO kompiuterinėje produkcijos apskaitos sistemoje. Tyrimo duomenų bazėje buvo registruojami duomenys tik tų karvių, kurių laktacija ne ilgesnė kaip 305 dienos.

Buvo vertinami tik tie karvių produktyvumo rodikliai, kurie pilnai atspindėjo visų trijų paros melžimų duomenis. Be to, nebuvo vertinami paros melžimų duomenys, jei bent vieno iš melžimų primilžis buvo mažesnis kaip 1 kg, pieno riebumas – mažesnis kaip 1,5 arba viršijo 9 %, o baltymingumas buvo mažesnis kaip 1 arba didesnis kaip 7 %.

Pieno riebumas ir baltymingumas nustatyti Gyvulininkystės instituto Chemijos laboratorijoje analizatoriumi Milko Scan 133B (Danija) infraraudonosios spinduliuotės vidurinės srities spindulių absorbcijos metodu. Analizatorius kas mėnesį buvo kalibruojamas VĮ „Pieno tyrimai“ kontroliniu pieno mėginių rinkiniu.

Tyrimo duomenų bazės kaupimui ir statistinei analizei buvo panaudoti Microsoft Office skaičiuoklės Excel 2003 duomenų analizės įrankiai. Šiame straipsnyje pateikti duomenų vidurkiai su standartine paklaida. Užsibrėžta, kad skirtumai tarp variacinių duomenų eilučių yra reikšmingi, jei taikant Stjudento kriterijų, $P < 0,05$.

TYRIMŲ REZULTATAI IR APTARIMAS

Ištirti tik tie žaliųjų ir žalmargių veislių tris kartus melžiamų karvių kontrolinių melžimų rodikliai, kurių visų melžimų primilžiai buvo ne mažesni kaip 1 kg.

Atitinkami koeficientai apskaičiuoti kaip individualių mėginių bendro paros primilžio rodiklių su atitinkamo melžimo primilžių rodikliais santykių vidurkiai.

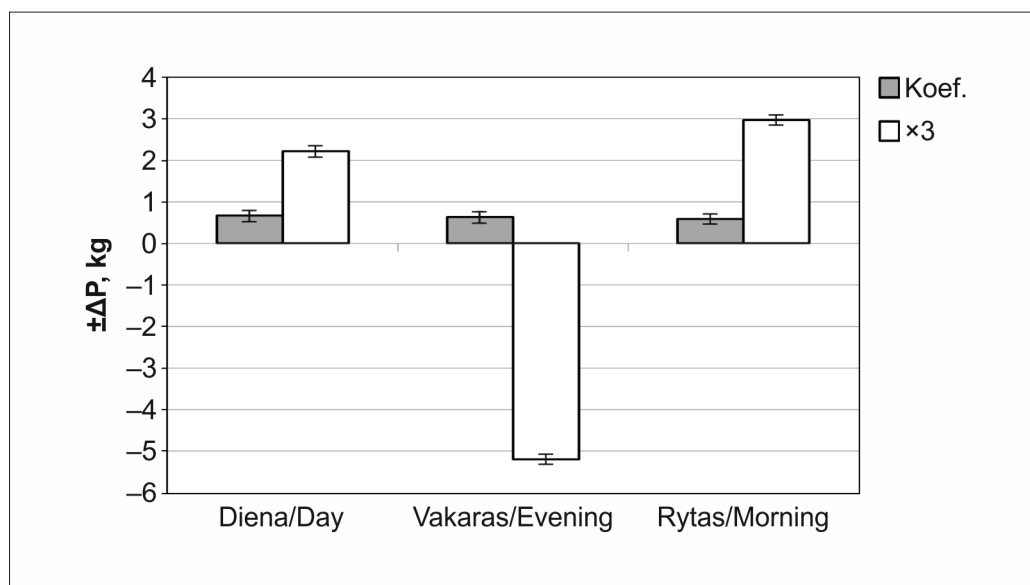
Paros primilžio perskaičiavimas iš vieno melžimo duomenų. Apdorojus tris kartus per parą melžiamų žaliųjų ir žalmargių veislių karvių 1118 paros melžimų duomenis, gauti tokie paros primilžio perskaičiavimo koeficientai:

$k_{Pd} = 2,852 \pm 0,014$, kai paros primilžis perskaičiuojamas iš dieninio melžimo duomenų;

$k_{Pv} = 3,725 \pm 0,019$, kai perskaičiuojamas iš vakarinio melžimo duomenų;

$k_{Pr} = 2,779 \pm 0,015$, kai perskaičiuojamas iš rytinio melžimo duomenų.

Šie koeficientai (kaip ir riebalų bei baltymų kiekių perskaičiavimo) galioja tik šio bandymo duomenų apibendrinimui, nes santykių reikšmės, kurių vidurkiai atitinka juos, pasiskirsčiusios ne pagal normalųjį skirstinį: ekscesas svyruoja nuo 37,2 iki 111,1, o asimetrija – nuo 2,6 iki 7,3. Taip yra, matyt, dėl to, kad duomenys atrinkti tik tų karvių, kurių pieno rodikliai tenkino minimalius reikalavimus, bei kurių visų paros melžimų duomenys buvo gauti. Dėl šių priežasčių buvo apskaityti kai kurių karvių kelių kontrolinių melžimų duomenys, o daugumos – tik po vieną. Nepaisant to, šio eksperimento koeficientų reikšmės atitinka bendrąsias tendencijas: vakarinį melžimą atitinkantis koeficientas yra didžiausias, o rytinį – mažiausias, tai yra ryte primelžiama daugiau pieno negu vakare.



1 pav. Primitinio perskaičiavimo iš bandymo vieno melžimo duomenų absoliuti vidutinė paklaida $\pm \Delta P$ (Koef – kai perskaičiuojama, naudojant nustatytus koeficientus; $\times 3$ – kai perskaičiuojama, vieno melžimo duomenis dauginant iš 3; paklaidos juostelėmis žymimos standartinės paklaidos $\pm SE$)

Fig 1. Absolute mean error for daily milk yield recalculated from the single milking data of experiment (Koef – recalculated using coefficient system; $\times 3$ – when the recorded data is multiplied by 3; error bars represent the Standard errors $\pm SE$)

Jei eksperimento metu karvių paros primitinis apskaičiuojamas naudojant nustatytus koeficientus, tai vidutinė absoliuti paklaida neviršija $0,66 \pm 0,13$ kg, tai yra santykinė paklaida buvo ne didesnė kaip 2,3 %. Kaip ir kitų autorių tyrimuose (pavyzdžiui, [5]), mažiausia paklaida gauta naudojantis nustatytais koeficientais, perskaičiuojant primitinį iš rytinio melžimo duomenų – $0,59 \pm 0,12$ kg, nors skirtumas tarp dieninio ar vakarinio melžimo paklaidų tebuvo 7,0–12,3 % ($P < 0,05$).

Jeigu paros primitinis apskaičiuojamas, atitinkamo melžimo duomenis padauginant iš 3, tai gaunama nuo 3,3 iki 8,2 karto ($P < 0,05$) didesnė absoliuti paklaida (1 pav.). Dauginant atskirų melžimų primitinius iš 3, didžiausios paklaidos gaunamos taip pat vakarinio melžimo metu. Rytinio ir dieninio melžimo metu gaunamas paklaidas jos viršija 0,8–1,3 karto.

Paros riebalų kiekio perskaičiavimas iš vieno melžimo duomenų. Apdorojus tris kartus per parą melžiamų žaliųjų ir žalmargių veislių karvių 1118 paros melžimų duomenis, gauti tokie paros riebalų kiekio perskaičiavimo koeficientai:

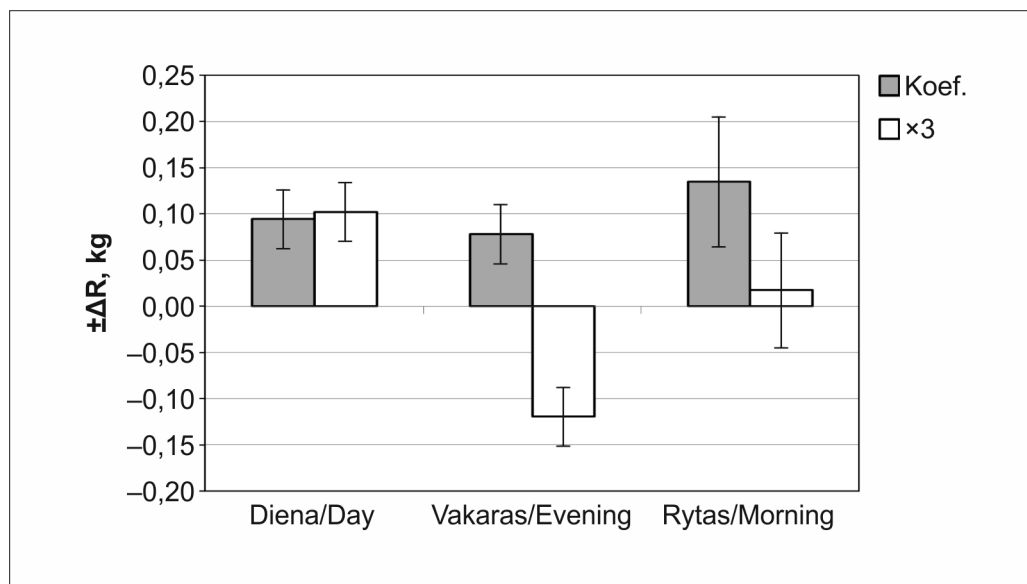
$kRd = 2,983 \pm 0,136$, kai paros riebalų kiekis perskaičiuojamas iš dieninio melžimo duomenų;

$kRv = 3,514 \pm 0,141$, kai perskaičiuojamas iš vakarinio melžimo duomenų;

$kRr = 3,273 \pm 0,032$, kai perskaičiuojamas iš rytinio melžimo duomenų.

Jei eksperimento metu karvių paros riebalų kiekis apskaičiuojamas naudojant nustatytus koeficientus, tai vidutinė absoliuti paklaida neviršija $0,136 \pm 0,071$ kg (arba 10,6 %).

Jeigu paros primilžis apskaičiuojamas atitinkamo melžimo duomenis padauginant iš 3, tai iš dieninio melžimo duomenų gavome 8,26 % ($P < 0,05$), o iš vakarinio – 1,53 karto ($P < 0,05$) didesnes paklaidas negu skaičiuojant iš rytinio melžimo duomenų. Rytinio melžimo duomenis dauginant iš trijų, riebalų kiekis apskaičiuotas 7,7 karto ($P < 0,05$) tiksliau negu naudojant koeficientą (2 pav.). Perskaičiuojant iš kitų melžimų – dieninio ir vakarinio, – riebalų kiekio paklaidos tesudarė 8,0–9,4 % viso paros riebalų kiekio. Kadangi santykinė paklaida neviršija 10 %, tai praktiniame naudojime gali būti pateisinama paros riebalų kiekio perskaičiavimui, vieno melžimo duomenis dauginant iš 3, nes netgi taikant daug sudėtingesnes perskaičiavimo schemas [13] didelių populiacijų mastu, garantuojamas ne didesnis kaip 18–20 % tikslumas.



2 pav. Riebalų kiekio perskaičiavimo iš bandymo vieno melžimo duomenų absoliuti vidutinė paklaida $\pm \Delta R$ (Koef – kai perskaičiuojama, naudojant nustatytus koeficientus; $\times 3$ – kai perskaičiuojama, vieno melžimo duomenis dauginant iš 3; paklaidos juostelėmis žymimos standartinės paklaidos $\pm SE$)

Fig 2. Absolute mean error for daily fat content recalculated from the single milking data of experiment (Koef – recalculated using coefficient system; $\times 3$ – when the recorded data is multiplied by 3; error bars represent the Standard errors $\pm SE$)

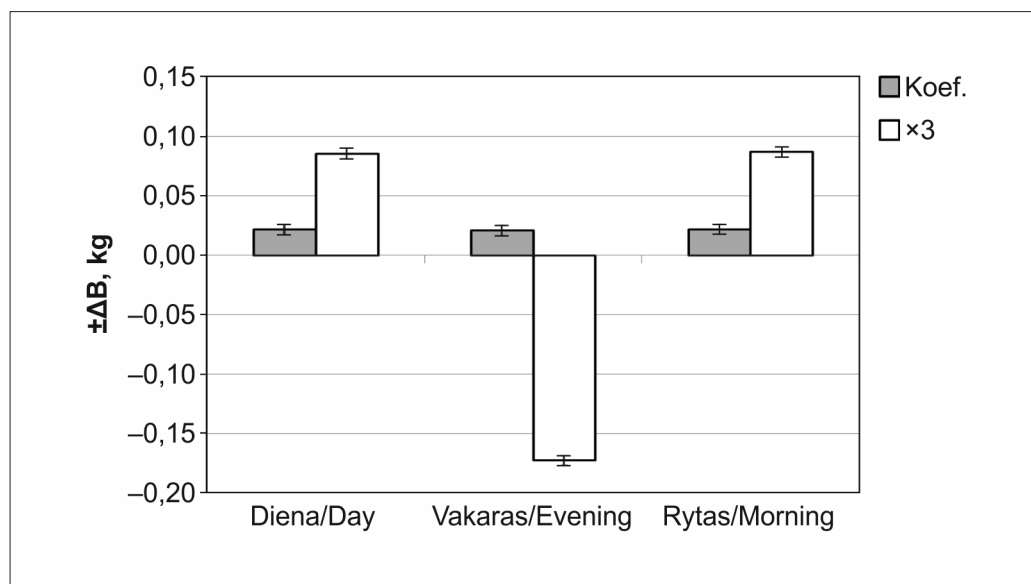
Mūsų tyrimų rezultatai patvirtina kitų tyrėjų nuomonę [7], kad naudojant trijų melžimų per parą schemą, didžiausios paklaidos gaunamos, skaičiuojant riebalų kiekį iš vieno melžimo duomenų. Norint padidinti skaičiavimo tikslumą, reikalingi didesnės apimties tyrimai, lyginant su kitų produktyvumo rodiklių (primilžio, baltymų kiekio) perskaičiavimo koeficientų nustatymo tyrimais [8].

Paros baltymų kiekio perskaičiavimas iš vieno melžimo duomenų. Apdorojus tris kartus per parą melžiamų žaliųjų ir žalmargių veislės karvių 1118 paros melžimų duomenis, gauti tokie paros baltymų kiekio perskaičiavimo koeficientai:

$k_{Bd} = 2,820 \pm 0,014$, kai paros baltymų kiekis perskaičiuojamas iš dieninio melžimo duomenų;

$k_{Bv} = 3,718 \pm 0,019$, kai perskaičiuojamas iš vakarinio melžimo duomenų;

$k_{Br} = 2,817 \pm 0,015$, kai perskaičiuojamas iš rytinio melžimo duomenų.



3 pav. **Baltymų kiekio perskaičiavimo iš bandymo vieno melžimo duomenų absoliuti vidutinė paklaida $\pm \Delta B$** (*Koef* – kai perskaičiuojama, naudojant nustatytus koeficientus; *x3* – kai perskaičiuojama, vieno melžimo duomenis dauginant iš 3; paklaidos juostelėmis žymimos standartinės paklaidos $\pm SE$)

Fig 3. **Absolute mean error for daily protein content recalculated from the single milking data of experiment** (*Koef* – recalculated using coefficient system; *x3* – when the recorded data is multiplied by 3; error bars represent the Standard errors $\pm SE$)

Jei eksperimento metu karvių paros baltymų kiekis apskaičiuojamas naudojant nustatytus koeficientus, tai vidutinė absoliuti paklaida neviršija $0,022 \pm 0,004$ kg (arba 2,2 %).

Jeigu paros primilžis apskaičiuojamas atitinkamo melžimo duomenis padauginant iš 3, tai, analogiškai paros primilžio skaičiavimo atvejui, gautos 4,0–8,3 kartus ($P < 0,05$) didesnės paklaidos negu naudojant koeficientus (3 pav.). Didžiausios paklaidos gautos (kaip ir primilžio bei riebalų kiekio skaičiavimo atvejais) vakarinio melžimo metu. Rytinio ir dieninio melžimo metu gaunamas paklaidas jos viršija dvigubai.

IŠVADOS

1. Naudojant At apskaitos metodą trijų paros melžimų schemoje, būtina bent minimalaus masto tyrimais nustatyti ir periodiškai koreguoti primilžio ir baltymų kiekio perskaičiavimo iš vieno melžimo duomenų koeficientus.
2. Jeigu negalima atlikti tyrimų, reprezentuojančių bent jau atskirą karvių veislę, tai, perskaičiuojant paros riebalų kiekį trijų paros melžimų schemoje, tikslinga vieno paros melžimo duomenis dauginti iš trijų.

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COMPARISON OF RECALCULATION SCHEMES FOR At METHOD RECORDED PRODUCTIVITY OF THRICE MILKED COWS

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SUMMARY

Cow productivity recording using At method of thrice milked cows might result in errors accounting for 18–20 %. The accuracy of recordings can be increased by choosing more complex recalculation schemes for daily milking data, by increasing the scope of experiments required to determine recalculation coefficients or by employing larger basis of statistical data. All these ways require additional funds and are more labour consuming, and, thus, the optimum relationship between the choosen recalculation scheme and its sufficient accuracy becomes a problem to be solved.

Control milking data of more than a thousand thrice-milked Lithuanian Red and Red-and-White cows kept in one herd were analyzed, two schemes for productivity recalculation and their practical application were compared. The first method was based on the system of coefficients, whereas the second – when the recorded data is multiplied by 3.

The study indicated that the use of the coefficient system resulted in errors not higher than 2.3, 10.6 and 2.2 % for, respectively daily yield from one milking data, fat content and protein content. The use of the second scheme resulted in 3.3–8.2, 4.0–8.3 times higher errors for daily milk yield and protein content, respectively. Errors for the fat content recalculated from the morning and evening data were, respectively, by 8.3 % and 1.5 times higher in comparison with the coefficient system. However, when morning milking data was multiplied by 3, the calculation of the daily fat content was 7.7 times more accurate.

On the basis of the study, it can be concluded that it is advisable to use the coefficient system for milk recordings provided the coefficients undergo recurrent testing for accuracy even by small scope experiments. Single milking data multiplication by 3 is valid only for daily fat content recalculation.

Keywords: cow productivity recording, At method, thrice milking

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СРАВНЕНИЕ СПОСОБОВ УЧЕТА ПРОДУКТИВНОСТИ КОРОВ, КОНТРОЛИРУЕМЫХ МЕТОДОМ At ПРИ ТРЕХРАЗОВОМ ДОЕНИИ

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РЕЗЮМЕ

При трехразовом доении коров осуществляя контроль продуктивности методом At, погрешности пересчета могут достигать 18–20 процентов. Точность учета может быть повышена путем выбора более сложных схем преобразования данных одного из суточных доений или увеличения объема и ужесточения условий экспериментов, необходимых для вычисления коэффициентов преобразования. Все эти методы требуют дополнительных финансовых и трудовых затрат. Поэтому важно найти оптимальное соотношение между выбираемой системой учета и удовлетворительной точностью.

В статье обобщены данные более тысячи контрольных доений одного стада коров литовской черно пестрой породы, которые доились три раза в сутки. Были сравнены два метода пересчета данных одной из доек и их практическая применимость: при использовании системы коэффициентов и при умножении данных на 3.

Было установлено, что, применяя систему коэффициентов, суточный надой по данным одной дойки был вычислен с относительной погрешностью не более 2,3 процента, содержание жира – не более 10,6 процента и содержание белка – с не более 2,2 процента. Данные одной дойки умножая на 3, погрешность вычисления суточного надоя молока увеличился от 3,3 до 8,2 раз, содержания белка – от 4,0 до 8,3 раз. Суточное содержание жира, пересчитанное из дневной и вечерней доек, вычислялось с, соответственно, на 8,3 процента и в 1,5 раза большей погрешностью, по сравнению с применением системы коэффициентов. Тем не менее, при умножении данных утренней дойки на 3, погрешность вычислена суточного содержания жира была в 7,7 раза меньшей.

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На основании результатов исследования предполагается, что, при контроле продуктивности коров методом At, целесообразно использовать систему коэффициентов, когда коэффициенты регулярно обновляются даже с помощью малообъемных экспериментов. Умножение данных одной дойки на 3 может быть оправданным лишь для пересчета суточного содержания жира.

Ключевые слова: контроль продуктивности коров, метод At, трехразовое доение

EFFICIENCY OF SUGARBEET PULP SILAGE IN THE DIETS FOR PEDIGREE HEIFERS

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ABSTRACT

Two analogous ($n = 5$) groups of Lithuanian Black-and-White heifers were used in a feeding trial conducted at the Institute of Animal Science of University of Health Sciences to investigate the efficiency of sugarbeet pulp silage in the diets of pedigree heifers. The heifers were grown from 10 to 14 months of age. The heifers in the control group were fed daily 1.0 kg hay, perennial grass-vetch-oat mixture silage ad libitum and 2.0 kg compound feed. The experimental heifers in the morning were fed perennial grass-vetch-oat mixture silage ad libitum, in the evening sugar beet pulp silage ad libitum and also given 1.0 kg hay and 1.0 kg compound feed. Sugarbeet pulp silage contained 23.35 % dry substance (d.s.) with 10.89 MJ metabolizable energy and 118.1 g crude protein per kg d.s. The heifers in the control and experimental groups gained daily, respectively, 812 and 783 g (3.6 % lower weight gain, $p > 0.5$). The heifers in both groups used almost the same amount of metabolizable energy per kg gain but the intake of crude protein was by 9.3 % lower for the experimental group of heifers. Feeding of the experimental heifers resulted in by 13.7 % lower feed price per ton of weight gain in comparison with the control group of heifers.

Keywords: *sugarbeet pulp silage, compound feed, pedigree heifers, growth, economic efficiency*

INTRODUCTION

Food industry development results in increasing amounts of by-products of a certain feeding value. Rational use of these products might increase feed resources, lower the utilization costs and, consequently, reduce environment pollution. Sugarbeet factories

after processing 1000 kg sugarbeet produce about 540 kg of sugarbeet pulp with approximately 13 % dry matter (DM) content [11]. For more effective feeding of animals, the DM content is increased to about 22 % by squeezing the pulp. Sugarbeet pulp remains fresh only for several days, therefore, its ensilage is suggested [2]. Pulp ensilage in trench silos or clamps with plastic sealing helps to preserve the nutrients and their quality for a longer time and is considered a beneficial technique not requiring larger capital investment. Ensilage of squeezed sugarbeet pulp containing 20–25 % DM differs from that of other feeds due to high pectin and low sugar contents in it [7, 13]. Pectin is easily degradable when affected by enzymes and the sugar content is sufficient for the inducement of active fermentation of thermophilic lactic acid bacteria [14, 15]. It is best to make silage from warm (about 50 °C) sugarbeet pulp because the temperature affects the fermentation of the pulp structural elements what is beneficial to fibre availability [6, 7]. Due to high content of pectin and peculiarities of its degradation in the digestive tract of cattle, sugarbeet pulp is valuable as an energy source. Breakdown of pectin in the rumen is slower compared with sugar or starch and, therefore, the pH value of the rumen contents remains more constant and favourable for the activities of fibre degrading micro flora [19]. Inclusion of sugarbeet pulp silage in the diets of cows allows to reduce the level of compound feeds [18]. Feeding of cows with high levels of concentrates results in lower fat content of milk [4], while partial replacement of concentrates with sugarbeet pulp silage allows to avoid this reduction. Sugarbeet pulp silage in the diets of lactating cows could constitute up to 30 % of the allowance on DM basis [8, 11]. In Lithuania, studies were carried out to determine the efficiency of sugarbeet pulp silage in the diets of milking cows and fattening bulls [3, 5]. However, so far there have been no trials involving pedigree heifers and their feeding with sugarbeet pulp silage. The purpose of the study was to investigate the efficiency of sugarbeet pulp silage in the diets for pedigree heifers by replacing part of compound feed.

MATERIAL AND METHODS

Two analogous by origin, age and weight groups (of Lithuanian Black-and-White heifers of five animals each) were used in the study conducted at the Institute of Animal Science of Lithuanian University of Health Sciences. The heifers were housed loose with five animals per pen. The heifers used in the trial were grown from 10 to 14 months of age. Food allowances were formulated according to the nutrition standards required to gain daily 750–800 g weight [11]. The heifers in the control group were offered 1.0 kg hay, perennial grass-vetch-oat mixture silage *ad libitum* and 2.0 kg compound feed. The heifers in the experimental group were given perennial grass-vetch-oat mixture silage *ad libitum* in the morning and sugarbeet pulp silage *ad libitum*, also 1.0 kg hay and 1.0 kg compound feed in the evening.

Press squeezed fresh sugarbeet pulp was delivered by joint-stock company *Nordic Sugar Kėdainiai* and ensilaged in a trench. Feed intakes were recorded by weighing

feeds and feed remainders once a week. At the Analytical Laboratory of the Institute standard methods were used to determine the chemical composition of feeds [1]. Weight gains were determined by weighing the heifers at the start, later on every month and at the end of the trial. Feed costs per heifer in the experimental period and per ton weight gain were estimated according to the price of feeds on as-fed basis.

Statistical analysis. Data were expressed as the mean response ($\pm$ standard deviation, SD) and differences in the means were evaluated using Student's t test [16]. All differences quoted in the text are significant at $P < 0.05$.

RESULTS AND DISCUSSION

Chemical composition, quality and nutritive value of sugarbeet pulp silage. The content of dry substance in sugarbeet pulp silage was 23.35 % with 10.89 MJ metabolizable energy and 118.1 g crude protein (Table 1).

Table 1. Chemical composition, quality and nutritive value of sugarbeet pulp silage and perennial grass-vetch-oat mixture silage 1 lentelė. Cukrinių runkelių griežinių ir daugiamečių žolių-vikių-avių siloso cheminė sudėtis, kokybė ir maistingumas		
Item Rodikliai	Sugarbeet pulp silage Cukrinių runkelių griežinių silosas	Perennial grass-vetch-oat mixture silage Daugiamečių žolių-vikių-avių silosas
Dry substance content (d. s.) in % Sausos medžiagos, %	23.35 $\pm$ 2,35	23.93 $\pm$ 2.08
In % relating to dry substance: Sausoje medžiagoje, %:		
Crude protein Žali balymai	11.81 $\pm$ 1,35	12.45 $\pm$ 0,89
Crude fat Žali riebalai	0.43 $\pm$ 0.04	3.43 $\pm$ 0.12
Crude fiber Žalia ląsteliena	28.01 $\pm$ 1.35	33.81 $\pm$ 1.48
Nitrogen free extracts NEM	54.30 $\pm$ 4.65	45.01 $\pm$ 5.02
Crude ash Žali pelenai	5.44 $\pm$ 0.89	5.31 $\pm$ 0.56
Calcium kalcis	0.66 $\pm$ 0.01	0.66 $\pm$ 0.02
Phosphorus Fosforas	0.11 $\pm$ 0.01	0.30 $\pm$ 0.01

Table 1. (Continued) 1 lentelė. (Tęsinys)		
Sugar Cukrus	1.71 ± 0.20	0.92 ± 0.15
Carotene mg/kg Karotinas, mg/kg	11.1 ± 1.25	35.4 ± 3.28
Metabolizable energy in MJ/kg d.s. Apykaitos energija, MJ/kg S.M.	10.89 ± 1.80	9.19 ± 1.35
Crude protein in g/kg d.s. Žalių baltymų, g/kg S.M.	118.1 ± 2.49	124.5 ± 1.54
Digestible protein in g/kg d.s. Virškinamųjų baltymų, g/kg S.M.	84.8 ± 3.62	81.1 ± 3.01
Organic acids in g/kg d.s. Organinių rūgščių, g/kg S.M	39.8 ± 2.05	89.5 ± 4.35
Including: Iš jų:		
Lactic acid in g/kg d.s. Pieno, g/kg S.M	18.8 ± 1.75	49.8 ± 3.68
Acetic acid in g/kg d.s. Acto, g/kg S.M	15.4 ± 0.89	31.8 ± 2.01
Butyric acid in g/kg d.s. Sviesto, g/kg S.M	5.6 ± 0.89	7.9 ± 0.56
pH of silage Siloso pH	4.15 ± 0.10	4.14 ± 0.19

The nutrients of sugarbeet pulp silage are digested very well. The organic matter digestibility from sugarbeet pulp silage reaches 86 %, while that of legume-grass silage 71 % [12]. In our earlier *in vitro* study sugarbeet pulp silage dry substance digestibility was high and accounted for 90.5 % [3]. Different silages have different nutrient digestibilities and this influences the energy value of the feed. The content of metabolizable energy in sugarbeet pulp silage was 18.5 % higher than that of perennial grass-vetch-oat mixture silage. Sugarbeet pulp silage contained lower levels of crude fat, crude fibre, phosphorus and carotene and higher levels of nitrogen-free extracts and sugar than perennial grass-vetch-oat mixture silage. The quality of the different silages was similar with lactic acid prevailing that accounted for 47.2 and 55.6 % of the total acid content in, respectively, sugarbeet pulp and perennial grass-vetch-oat mixture silages.

Trial with pedigree heifers. When the amount of compound feed offered to the heifers in the experimental group was twice lower (1.0 kg), the daily silage intake by the experimental heifers was 9.6 % higher than that by the heifers in the control group (Table 2).

Table 2. Average diets of pedigree heifers on as-fed basis 2 lentelė. Veislinių telyčių paros daviniai pagal suėstus pašarus		
Feedstuff Pašarai	Group Grupės	
	Control kontrolinė	Experimental tiriamoji
Perennial grass hay in kg Daugiamečių žolių šienas, kg	0.8	0.9
Perennial grass-vetch-oat mixture silage in kg Daugiamečių žolių-vikių-avižų silosas, kg	19.7	9.7
Sugarbeet pulp silage in kg Cukrinių runkelių griežinių silosas, kg	–	11.9
Compound feed in kg Kombinuotas pašaras, kg	2.0	1.0
Mineral-vitamin mixture in kg Mineralinis-vitamininis papildas G-38, kg	–	0.05
Analysis of the diet:		
Dry substance in kg Sausos medžiagos, kg	7.0	6.7
Metabolizable energy in MJ Apykaitos energija, MJ	69.17	67.76
Crude protein in g Žali baltymai, g	941	826
Digestible protein in g Virškinamieji baltymai, g	645	581
Crude fiber in g Žalia ląsteliena, g	1983	1897
Calcium in g Kalcis, g	57.3	57.9
Phosphorus in g Fosforas, g	41.3	33.9
Carotene in mg Karotinas, mg	164	120

The feeding pattern applied to the experimental heifers resulted in by 4.3, 2.0 and 12.2 % lower intake of, respectively, dry substance, metabolizable energy and crude protein.

The amount of feeds on as-fed basis and other heifer growth data are presented in Table 3. The formula of the compound feed was the same for the both groups of animals. As the compound feed allowance for the experimental heifers was lower, the diet of the experimental group was additionally supplemented with 5.9 kg mineral-vitamin premix per animal. The heifers in the control and experimental groups gained daily 812 and 783 g, respectively. The weight gain of the experimental heifers was 3.6 % lower ($p > 0.5$). During the trial the growth intensity of the heifers was aimed to reach calving at the age of 23–25 months. At the age of 14 months, the weight of the control and experimental heifers was, respectively, 347.0 and 345.2 kg. The growth intensity in both groups was sufficient. In order to have 550–600 kg cows, first calving at the age of 23–26 months and milk production of 6000–6500 kg per lactation, the heifers should be grown intensively [9]. According to Spiekens et al. the growth intensity should be as follows: daily gains of 750–800 g to reach 200 kg weight, 800–850 g to reach 200–400 kg weight and 700–750 g for 400–600 kg weight [17].

Table 3. Growth data for pedigree heifers 3 lentelė. Veislinių telyčių augimo duomenys		
Item Rodikliai	Group Grupės	
	Control kontrolinė $x \pm SD$	Experimental tiriamoji $x \pm SD$
Heifer weight in kg: Telyčių svoris, kg		
at the start (10 months) bandymo pradžioje (10 mėn.)	251.2 $\pm$ 7.07	252.8 $\pm$ 9.80
at the end (14 months) bandymo pabaigoje (14 mėn.)	347.0 $\pm$ 9.65	345.2 $\pm$ 9.29
Daily gain in g Prieaugis per parą, g	812 $\pm$ 29.62	783 $\pm$ 24.34
Food consumption in 118 days in kg: Per 118 dienų telyčiai sušerta, kg		
Perennial grass hay Daugiametinių žolių šieno	94.4	106.2
Perennial grass-vetch-oat mixture silage Daugiametinių žolių-vikių-avižų siloso	2324.6	1144.6
Sugarbeet pulp silage Cukrinių runkelių griežinių siloso	–	1404.2
Compound feed Kombinuoto pašaro	236.0	118.0
Mineral-vitamin mixture Mineralinio-vitamininio papildu G-38	–	5.9

Table 3. (Tęsinys) 3 lentelė. (Continued)		
Feed intake production: Iš sušertų pašarų gauta:		
Metabolizable energy in MJ Apykaitos energijos, MJ	8162.06	7995.68
Crude protein in kg Žalių baltymų, kg	111.0	97.1
Used per 1 kg of gain: 1 kg prieaugio sunaudota:		
Metabolizable energy in MJ Apykaitos energijos, MJ	85.20	86.53
Crude protein in g Žalių baltymų, g	1159	1051
Price of consumed feeds in EUR: Sušertų pašarų kaina, EUR		
per heifer in 118 days 1 telyčiai per 118 dienų	72.99	60.77
per 1 t gain 1 t prieaugio	761.87	657.66

In our study, the heifers in both groups used almost the same amount of metabolizable energy per kg gain, but the content of crude protein used by the experimental heifers was 9.3 % lower compared with the heifers in the control group. The price of feeds for the experimental group of heifers that were fed hay, perennial grass-vetch-oat mixture and sugarbeet pulp silages, also 50 % lower amount of compound feed was 13.7 % lower per ton of weight gain in comparison with the control group of animals.

CONCLUSIONS

The nutritive value of sugarbeet pulp silage was high. It had 23.35 % dry substance content with 10.89 MJ metabolizable energy and 118.1 g crude protein per kg d. s. Different feeding of heifers from 10 to 14 months of age had no significant influence on their growth. The use of sugarbeet pulp silage in the diets for pedigree heifers from 10 to 14 months of age resulted in by 50 % lower amount of compound feed in the diet and by 13.7 % lower feed intake per ton of weight gain.

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CUKRINIŲ RUNKELIŲ GRIEŽINIŲ SILOSO EFEKTYVUMAS VEISLINIŲ TELYČIŲ RACIONE

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SANTRAUKA

Bandymas atliktas Lietuvos sveikatos mokslų universiteto Gyvulininkystės instituto Bandymų skyriuje su dviem analogiškais pagal kilmę, amžių ir svorį Lietuvos juodmargių veislės telyčių grupėmis, po 5 gyvulius kiekvienoje. Bandyme telyčios augintos nuo 10 iki 14 mėn. Kontrolinės grupės veislinių telyčių racioną sudarė: šienas – 1,0 kg, daugiamečių žolių vikių-avižų mišinio silosas – iki soties, kombinuotasis pašaras – 2,0 kg. Tiriamosios grupės telyčios ryte gavo iki soties daugiamečių žolių-vikių-avižų mišinio siloso, vakare – iki soties cukrinių runkelių griežinių siloso, šieno gavo tiek pat, kiek ir kontrolinės grupės telyčios, o kombinuotojo pašaro – po 1,0 kg per dieną. Cukrinių runkelių griežinių silosas pasižymėjo aukšta pašarine verte. Jame buvo 23,35 % sausųjų medžiagų, kurių 1 kilograme buvo 10,89 MJ apykaitos energijos ir 118,1 g žalių baltymų. Skirtingas veislinių telyčių šėrimas nuo 10 iki 14 mėnesių amžiaus neturėjo esminės įtakos jų augimui: tiriamosios grupės telyčios priaugo vidutiniškai po 783 g, o kontrolinės 812 g per parą, arba 3,6 % ($P > 0,5$) daugiau. Cukrinių runkelių griežinių siloso panaudojimas veislinių telyčių auginimui nuo 10 iki 14 mėn. amžiaus įgalino sumažinti 50 % kombinuotojo pašaro kiekį ir 13,7 % atpiginti pašarų sąnaudas 1 t prieaugio gauti.

Raktažodžiai: cukrinių runkelių griežinių silosas, kombinuotasis pašaras, veislinės telyčios, auginimas, ekonominis efektyvumas

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ЭФФЕКТИВНОСТЬ СИЛОСА СВЕКЛОВИЧНОГО ЖОМА В РАЦИОНЕ ПЛЕМЕННЫХ ТЕЛОК

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РЕЗЮМЕ

Опыт проведен в Отделе экспериментального развития и опытов Института животноводства ЛУНЗ с телками литовской черно-пестрой породы ($n = 10$). В опыте телок выращивали от 10 до 14 мес. Телки контрольной группы получали рацион сено – 1,0 кг, силос многолетних трав викоовсяной – вволю и комбикорм – 2 кг. Телки опытной группы утром получали силос многолетних трав викоовсяной – вволю, а вечером силос обезвоженного свекловичного жома – вволю и комбикорм – 1 кг. Установлено, что в силосованном обезвоженном свекловичном жоме было 23,35 % сухого вещества (СВ), а в 1 кг СВ – 10,89 Мд обменной энергии и 118,1 г сырого белка. Разное кормление телок, от 10 до 14 мес., не повлияло на прирост, у телок опытной группы он был – 783 г, а контрольной – 812 г в сутки или 3,6 % ($P > 0,5$) больше. Применение силоса обезвоженного свекловичного жома в рационе телок возрастом от 10 до 14 мес. 50 % уменьшило скармливание комбикорма и снизило себестоимость кормов на 13,7 % на прирост 1 т живой массы.

Ключевые слова: силос свекловичного жома, племенные телки, выращивание, экономическая эффективность

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SKYSTO PROBIOTIKO ĮTAKA KIAULIŲ PRODUKTYVUMUI BEI KIAULIENOS KOKYBEI

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SANTRAUKA

Norėdami ištirti skysto probiotiko panaudojimo galimybes penimų kiaulių mityboje, Lietuvos sveikatos mokslų universiteto Gyvulininkystės institute (LSMU GI) atlikome bandymą su Lietuvos baltųjų × Norvegijos landrasų × pjentrenų bei Lietuvos baltųjų × Norvegijos landrasų × Švedijos jorkšyrų mišrūnais. Kontrolinės ir tiriamųjų grupių kiaulės šėrėme 2 kartus per parą sausais kombinuotaisiais pašarais. Tačiau tiriamųjų grupių kiaulėms dar papildomai buvo duodama skysto probiotiko, sudaryto iš bakterijų *Bacillus subtilis*, *Bifidobacterium animalis*, *Bifidobacterium bifidum*, *Bifidobacterium longum*, *Lactobacillus acidophilus*, *Lactobacillus bulgaricus*, *Lactobacillus casei*, *Lactobacillus delbrueckii*, *Lactobacillus fermentum*, *Lactobacillus plantarum*, *Lactococcus diacetylactis*, *Lactococcus lactis*, *Rhodopseudomonas palustris*, *Saccharomyces cerevisiae*, *Streptococcus thermophilus* kultūrų. Jis buvo aktyvuojamas su vandeniu (I ml/l – II grupei, 2 ml/l – III grupei) bei įterpiamas į pašarus tiriamosioms kiaulėms prieš šėrimą.

Tyrimų duomenimis, penimoms kiaulėms su pašarais panaudojus vandenį aktyvuotą (I ir 2 ml/l) probiotiką, augimo intensyvumas iš esmės nepakito. Minėtas priedas 0,9–2,8 % sumažino pašarų sąnaudas kilogramui priaugti, nors šiuo atveju pašarų suėdimo per parą pokyčių dėsningumų nenustatyta. Kiaulių, gavusių probiotiko, skerdenos kokybė, mėsos ir lašinių cheminiai bei fiziniai rodikliai mažai skyrėsi nuo kontrolinių.

Raktažodžiai: probiotikas, kiaulių augimas, pašarų sąnaudos, skerdenos kokybė, mėsos cheminė sudėtis

ĮVADAS

Uždraudus antibiotikų naudojimą, kiaulių mitybos pagerinimui pradėta taikyti saugius biotechnologijos produktus, teigiamai veikiančius sveikatingumą bei produktyvumą. Vieni iš jų – probiotikai – mikrobiniai preparatai, sukurti natūralios žarnyno mikrofloros

pagrindų. Šios biologiškai aktyvios medžiagos ne tik antagonistiskai veikia patogeninius mikrobus, normalizuoja žarnyno veiklą, stiprina organizmo imuninę sistemą bei atsparumą ligoms, bet ir skatina virškinimo fermentų sintezę, dėl ko pagerėja maisto medžiagų rezorbcija, virškinimas bei įsisavinimas. Vertinga probiotikų savybė ta, kad jie nesunaikina žarnyno mikrofloros, yra ekologiški ir nesikaupia gyvūno organizme. Todėl probiotikai galėtų būti gera alternatyva antibiotikams. Probiotinius preparatus daugiausiai sudaro *Lactobacilius*, *Bifidobacterium*, *Enterococcus*, *Pediococcus* ir *Streptococcus*, *Bacillus licheniformis*, *Bacillus subtilis*, *Bacillus cereus* genčių bakterijų kamienų bei mielių *Saccharomyces cerevisiae* padermės [24, 28]. Paršelių ir vyresnių kiaulių mityboje panaudojus probiotikus, turinčius bakterijų *Lactobacillus acidophilus*, *Bifidobacterium bifidum*, *Enterococcus faecium* ir pan., geriau išsivysto teigiama žarnyno mikroflora bei pusiausvyra, pagerėja virškinamojo trakto veikla, sumažėja viduriavimo, kolibakteriozės ir kitų susirgimų atvejų. Tokiu būdu gyvuliai geriau auga bei vystosi, o tai užtikrina didesnius prieaugius, geresnę pašarų konversiją bei skerdenos ir mėsos kokybę [3, 24, 29].

Daugiausia tyrinėtose probiotikų taikymo jauniems paršeliams galimybės. Kyriakis ir kt. [15], Taras ir kt. [25, 26] savo darbuose nurodo teigiamą probiotikų poveikį paršelių sveikatingumui bei produktyvumui. Jie ypač efektyvūs ankstyvajame nujunkymo laikotarpyje (28 d. amžiuje), kai susiduriama su mažų paršelių stresine būseną [25, 28, 29]. Kvietkutė ir kt. [16], Holl [9] nustatė, kad žindomų ir nujunkytų paršelių pašaruose esant probiotiko *Levucell SB*, pagerėjo sveikatingumas, jų svoris buvo 2–10 % didesnis, pašarų sąnaudos 1 kg prieaugio sumažėjo 9–18 %, ženkliai mažiau buvo kritimų atvejų. Kitų autorių duomenimis, pašarų praturtinimas probiotikais taip pat sumažino paršelių viduriavimo ir kritimų atvejus, pagerino prieaugius ir pašarų konversiją [3, 11]. Hieu ir Tho [8] tyrinėjo skystų probiotikų efektyvumą, gydant paršelių viduriavimą. Autoriai nustatė, kad antimikrobinės šių probiotikų savybės gerėjo didinant dozę. *E. coli*, *Salmonella*, *Staphylococcus*, *Streptococcus*, *Shigella*, *C. perfringens* bakterijų augimas, įskaitant antibiotikams atsparias rūšis, buvo visiškai sustabdytas, panaudojus 10 ml probiotiko.

Taip pat esama duomenų ir apie probiotikų panaudojimą penimoms kiaulėms. Alexopoulos ir kt. [1] nurodo, jog į pašarus įmaišius 200, 400, 600 g/t probiotiko *BioPlus 2B*, pagerėja sveikatingumas, augimo sparta bei pašarų konversija, skerdenos kokybė. Jerešiūnas ir kt. [10] į pašarus įterpę probiotinių preparatų „*Bonvital*“ ($3,03 \times 10^9$ KSV/kg *Enterococcus faecium*) bei „*BioMin Imbo*“ ($0,75 \times 10^8$ KSV/kg *Enterococcus faecium*), taip pat gavo teigiamus rezultatus. Juknos ir kt. [12, 13] duomenimis, į penimų kiaulių pašarus įmaišius probiotikų *Yesture*, *Microbond* bei „*LABYuc-Probio*“ (0,2 %), kiaulės per parą priaugo nuo 3,8 iki 20 % daugiau negu kontrolinės. Taip pat minėti priedai turėjo teigiamą poveikį kiaulienos kokybei – skerdenos išeiga buvo 2 % didesnė, sumažėjo mėsos virimo nuostoliai, pagerėjo jos vandens rišlumas, konsistencija. Bartkevičiūtė ir kt. [2] nurodo, jog esant kiaulių pašaruose probiotiko *Bonvital*, prieaugiai per parą buvo 1,5–3 % didesni, nors tai neturėjo didelės įtakos pašarų sąnaudoms. Vaičiulaitienės ir kt. [27] duomenimis, į pašarus įmaišius preparato *Yeasture*, kiaulės augo sparčiau – per visą auginimo laikotarpį prieaugis per parą buvo 27,7 % didesnis, o pašarų sąnaudos 1 kg priaugti sumažėjo 24,4 %. Mėsos fizinėms savybėms probiotikas reikšmingos įtakos neturėjo.

Kai kurie autoriai [14, 21] į paršelių bei penimų kiaulių racionus įterpė probiotikų, esminės įtakos augimo intensyvumui, pašarų sunaudojimui bei ėdamumui nenustatė. Caisin ir kt. [5] paršeliams naudojė probiotiką „*Biomin Imbo*“, taip pat negavo teigiamų rezultatų. Richter ir kt. [22] duomenimis kiaulių, racionuose esant probiotikų, augimo sparta, pašarų sąnaudos, skerdenos kokybė beveik nesiskyrė nuo kontrolės, tik 0,9–2,7 % padidėjo raumeningumas. Büttner ir Oster [4], kiaulių racionuose panaudoję 2,5–3,0 % probiotiko *BioPlus 2B*, gavo 1,2 % mažesnius prieaugius, o pašarų ėdamumas pablogėjo netgi 3,4 %. Autorių duomenimis, probiotikas neturėjo esminės įtakos skerdenos kokybei.

Taigi, literatūroje kol kas nesama vieningos nuomonės apie probiotikų taikymą kiaulių mityboje. Dėl probiotinių preparatų gausos sudėtinga pasakyti, kurios probiotikų rūšys bei jų dozė yra efektyvesnės ir daro didesnę poveikį gyvulio organizmui. Kai kur teigiama, kad šiuo klausimu gauti rezultatai būna prieštaringi ir įvairūs [17, 18]. Tam įtakos gali turėti mikroorganizmų genčių kamienų skirtumai, probiotiko kiekis pašaruose, kiaulių laikymo sąlygos, raciono sudėtis, šėrimo technologijos ir kiti faktoriai.

Mūsų darbo tikslas – ištirti skysto probiotiko, sudaryto iš specifinių bakterijų *Bacillus subtilis*, *Bifidobacterium*, *Lactobacillus*, *Lactococcus*, *Rhodopseudomonas*, *Saccharomyces*, *Streptococcus* kultūrų įtaką kiaulių augimo intensyvumui, pašarų sunaudojimui, skerdenos kokybei, mėsos ir lašinių cheminiams bei fiziniams rodikliams.

TYRIMŲ SĄLYGOS IR METODAI

Lietuvos sveikatos mokslų universiteto Gyvulininkystės institute (LSMU GI) atlikome bandymą su Lietuvos baltųjų × Norvegijos landrasų × pjetenų bei Lietuvos baltųjų × Norvegijos landrasų × Švedijos jorkšyrų mišrūnais pagal 1 lentelėje nurodytą schemą. Analogų principu pagal kilmę, amžių, svorį, imtimą bei lytį buvo sudarytos 3 kiaulių grupės, po 12 gyvulių kiekvienoje. Pradinis kiaulių svoris buvo apie 13–15 kg (amžius – 50–60 dienų), realizuojant – 105–120 kg (amžius – 180–210 dienų).

1 lentelė. Bandymo schema Table 1. Experimental design		
Grupės Groups	Kiaulių skaičius Number of pigs	Šėrimo charakteristika Characteristic of feeding
I – kontrolinė I (Control)	12	Pagrindinis racionas (PR)* Basic ration (BR)*
II – tiriamoji II (Experimental)	12	PR+probiotikas 1 ml/l vandens (santykis 1:1000) BR+probiotic of 1 ml/ 1 l water (ratio 1:1000)
III – tiriamoji III (Experimental)	12	PR+probiotikas 2 ml/l vandens (santykis 2:1000) BR+probiotic of 2 ml/ 1 l water (ratio 2:1000)
*PR sudarė kombinuotasis pašaras *BR was compound feed		

Bandymo metu kiaules laikėme vienodomis sąlygomis garduose, po 6 gyvulius kiekviename, šėrėme pagal rekomenduojamas normas [6] 2 kartus per parą kombinuotaisiais pašarais iki soties.

Tiek kontrolinės (I), tiek tiriamųjų (II ir III) grupių kiaulės gavo vienodus kombinuotuosius pašarus, kurių sudėtis ir maistingumas nurodyti 2 lentelėje. Antros ir trečios tiriamųjų grupių kiaulėms dar buvo duodama skysto probiotiko (SCD Bio Livestock™) sudaryto iš bakterijų *Bacillus subtilis*, *Bifidobacterium animalis*, *Bifidobacterium bifidum*, *Bifidobacterium longum*, *Lactobacillus acidophilus*, *Lactobacillus bulgaricus*, *Lactobacillus casei*, *Lactobacillus delbrueckii*, *Lactobacillus fermentum*, *Lactobacillus plantarum*, *Lactococcus diacetylactis*, *Lactococcus lactis*, *Rhodopseudomonas palustris*, *Saccharomyces cerevisiae*, *Streptococcus thermophilus* kultūrų (gamintojas – BioSyntropy Solutions, SCD LLC, Kansas City, MO 64106). Šis preparatas buvo aktyvuojamas su vandeniu: 1 ml/l – II grupei, 2 ml/l – III grupei (1 lentelė) bei įterpiamas į pašarus tiriamųjų grupių kiaulėms prieš šėrimą. Antros tiriamosios grupės kiaulės vidutiniškai per parą gaudavo probiotiko: 60–90 dienų amžiuje – 2 ml, 91–120 dienų amžiuje – 5 ml, virš 120 dienų amžiaus – 7 ml, o trečios tiriamosios – atitinkamai 4 ml, 10 ml, 14 ml. Sunaudojamo probiotiko kiekį kiaulėms per parą nustatėme pagal vandens suvartojimo normas [6].

2 lentelė. **Kombinuotųjų pašarų sudėtis ir maistingumas**
Table 2. **Composition and analysis of diets**

Rodikliai Item	Kiaulių amžius dienomis Age of pigs in days	
	60–90	Virš 90 Over 90
Miežiai % Barley, %	40	35,6
Kviečiai % Wheat, %	36	10
Kvietrugiai % Triticale, %	–	30
Kukurūzai % Maize, %	–	8
Kvietinės sėlenos % Wheat bran, %	4	–
Sojų rupiniai % Soybean meal, %	10	–
Saulėgrąžų rupiniai % Sunflower meal, %	–	7
Rapsų išspaudos % Rapeseed cake, %	4	7,6
Žuvų miltai % Fish meal, %	2	-

2 lentelė. (Tęsinys) Table 2. (Continued)		
Augalinis aliejus % Vegetable oil, %	2	-
Monokalcio fosfatas % Monocalcium phosphate, %	1	0,8
Pašarinis kalkakmenis % Limestone, %	0,8	0,7
Valgomoji druska % Salt, %	0,2	0,3
Kilogramė pašaro yra: Analytical data/kg feed:		
sausųju medžiagų kg dry matter, kg	0,86	0,87
apykaitos energijos MJ metabolizable energy, MJ	12,7	12,6
žalių baltymų g crude protein, g	167,1	148,3
lizino g lysine, g	8,1	8,0
metionino g methionine, g	3,4	2,8
treonino g threonine, g	4,3	4,3
ląstelienos g fibre, g	36,7	64,9
kalcio g calcium, g	8,5	7,9
fosforo g phosphorus, g	5,5	4,8
100 g baltymų yra lizino g 100 g proteine contain lysine g	4,8	5,4

Pašarų cheminė sudėtis ir maistingumas buvo ištirti Lietuvos sveikatos mokslų universiteto Gyvulininkystės instituto Chemijos laboratorijoje pagal standartinius metodus, nurodytus AOAC, 1990a [19]. Augimo intensyvumui nustatyti kiaules svėrėme individualiai prieš rytinį šėrimą bandymo pradžioje, vėliau – kas mėnesį ir bandymo pabaigoje. Pašarų apskaita vykdyta, kasdien atskirai sveriant kiekvieno gardo pašarus prieš šėrimą.

Bandymo pabaigoje AB „Kiaulių veislininkystė“ (Radviliškio r.) atliktas kontrolinis kiaulių skerdimas. Skerdenų įvertinimui iš kiekvienos grupės analogų principu buvo atrinkta po 11 kiaulių. Kiaulių skerdenos buvo vertinamos pagal „Veislinių kiaulių produktyvumo kontrolės, vertinimo, informacijos kaupimo ir teikimo taisyklės“, patvirtintas 2003 m.

Mėsos ir lašinių kokybės vertinimui iš kiekvienos grupės analogų principu atrinkome po 4 kiaules (2 kiaušaites ir 2 kastratus). Mėsos cheminė sudėtis buvo ištirta pagal standartinius metodus, nurodytus AOAC, 1990a [19], pH – potenciometrinio metodu, panaudojant laboratorinį pH-metrą „Knick pH-766-Meter“ (Calimatic, Berlin, Germany), vandens rišlumas – Grau ir Hamm [7] metodu, virimo nuostoliai – Schilling [23] metodu, lašinių lydimosi temperatūra – kapiliariniu metodu [30], hidrolizės skaičius – pagal standartinį metodą, nurodytą AOAC, 1990b [20]. Visi tyrimai atlikti Lietuvos sveikatos mokslų universiteto Gyvulininkystės instituto Chemijos laboratorijoje.

Tyrimų duomenys buvo apdoroti statistinės analizės metodu, panaudojant programą STATISTIC for Windows (Statistica, Version 7.0, Data Analysis Software System; StatSoft, Inc., Tulsa, OK, USA). Buvo apskaičiuotas aritmetinis vidurkis (M) ir aritmetinio vidurkio paklaida ($\pm m$). Skirtumai tarp grupių įvertinti pagal Stjudento kriterijų. Pasirinktas reikšmingumo lygmuo – $P \leq 0,05$.

TYRIMŲ REZULTATAI

Kiaulių augimas. Į antros grupės 60–90 dienų amžiaus kiaulių pašarus įterpus 1 ml/l vandenyje aktyvuoto skysto probiotiko, augimas iš esmės nepakito (3 lentelė). Nors šiuo atveju išryškėjo trečios grupės kiaulių, gavusių didesnę (2 ml/l) suaktyvinto minėto priedo kiekį, augimo gerėjimo tendencija – per parą jos priaugo 14,3 % daugiau, lyginant su kontrolinėmis, tačiau statistiškai patikimų skirtumų tarp grupių nenustatyta. 91–120 dienų amžiaus laikotarpyje bei virš 120 dienų amžiaus kiaulėms panaudojus 1 ml/l (II grupė) ir 2 ml/l (III grupė) vandenyje aktyvuoto probiotiko, prieaugiai iš esmės nesiskyrė nuo kontrolės. Per visą bandymo laiką visų grupių kiaulės augo panašiai.

Probiotikas kiaulių sveikatingumui didelės įtakos neturėjo.

Panašius rezultatus yra gavę Keegan ir kt. [14], Richter ir kt. [21, 22], kurie į paršelių bei penimų kiaulių pašarus įmaišę probiotikų, taip pat nenustatė esminio poveikio augimo spartai. Tik mūsų tyrimų duomenimis, 60–90 dienų amžiaus laikotarpiu kiaulėms panaudojus didesnę probiotiko kiekį (2 ml/l), nors ir pastebėta geresnio augimo tendencija, tačiau skirtumai statistiškai nepatikimi. Kiti autoriai įterpę į kiaulių pašarus probiotikų *BioPlus 2B* (2,5–3 %) bei *BioMin Imbo* (0,1–0,2 %), netgi gavo nuo 1,2 iki 7,7 % mažesnius prieaugius [4, 5]. Geresnius kiaulių augimo duomenis yra nustatę Alexopoulos ir kt. [1], Jerežiūnas ir kt. [10], Jukna ir kt. [12, 13], Vaičiulaitienė ir kt. [27].

Pašarų sunaudojimas. Tyrimų duomenimis, III grupės kiaulės 60–90 dienų amžiaus laikotarpyje, gavusios didesnę vandenyje suaktyvinto probiotiko kiekį (2 ml/l), 1 kg prieaugio sunaudojo 5 % mažiau pašarų, negu kontrolinės (4 lentelė). Esant 1 ml/l šio priedo (II grupė), pašarų sąnaudos kilogramui priaugti beveik nesiskyrė nuo kontrolės. Laikotarpiu nuo 91 iki 120 dienų amžiaus kiaulėms panaudojus 1 ml/l (II grupė) ir 2 ml/l (III grupė) probiotiko, pašarų sąnaudos 1 kg prieaugio sumažėjo atitinkamai 4,5 ir 7,2 %, lyginant su kontrole. Virš 120 dienų amžiaus kiaulių, gavusių 1 ml/l probiotiko (II grupė),

3 lentelė. Kiaulių augimo rezultatai Table 3. Growth rate of pigs			
Rodikliai Item	Grupės Groups		
	I (n = 12)	II (n = 12)	III (n = 12)
	M ± m	M ± m	M ± m
Kiaulių svoris kg: Weight of pigs, kg:			
bandymo pradžioje at the start	13,32 ± 0,634	13,28 ± 0,780	13,48 ± 0,628
90 dienų amžiuje at the 90 days of age	22,80 ± 1,163	24,07 ± 2,055	25,53 ± 1,668
120 dienų amžiuje at the 120 days of age	45,50 ± 2,216	46,37 ± 3,369	49,54 ± 3,003
bandymo pabaigoje at the end	116,25 ± 3,173	120,37 ± 3,341	117,29 ± 3,467
Vidutinis prieaugis per parą g: Average daily gain, g:			
60–90 dienų amžiuje at 60–90 days of age	273 ± 24,288	290 ± 30,309	312 ± 27,824
91–120 dienų amžiuje at 91–120 days of age	668 ± 40,116	656 ± 41,073	706 ± 49,001
virš 120 dienų amžiaus over 120 days of age	865 ± 31,549	875 ± 30,117	844 ± 19,066
per visą bandymo laiką during the trial	688 ± 21,121	697 ± 17,981	683 ± 13,382

pašarų sąnaudos 1 kg priaugti buvo 2,9 % mažesnės, o gavusioms 2 ml/l (III grupė), 2,3 % didesnės, negu kontrolinių. Per visą bandymo laiką II ir III grupių kiaulės 1 kg priaugti pašarų sunaudojo atitinkamai 2,8 % ir 0,9 % mažiau, lyginant su kontrolinėmis.

Analogiškus rezultatus yra gavę Jerešiūnas ir kt. [10], Jukna ir kt. [12, 13], Vaičiulaitienė ir kt. [27]. Autoriai nurodo, jog probiotikų panaudojimas kiaulėms nuo 3,8 iki 24,4 % sumažino pašarų sąnaudas 1 kg prieaugio. Bartkevičiūtės ir kt. [2] duomenimis, pirmajame bandyme, esant pašaruose probiotiko *Bonvital*, pašarų sunaudojimas mažai skyrėsi nuo kontrolės. Tik antrojo bandymo metu minėtas priedas 3 % sumažino pašarų sąnaudas 1 kg priaugti.

Išanalizavę 4 lentelėje pateiktus duomenis matome, jog II ir III grupių kiaulėms 60–90 dienų amžiaus laikotarpyje panaudojus vandenyje aktyvuotą probiotiką (atitinkamai 1 ir 2 ml/l), 9,1 % pagerėjo pašarų suėdimas per parą, lyginant su kontrolinėmis. Kiaulės, laikotarpį nuo 91 iki 120 dienų amžiaus gavusios 1 ml/l minėto priedo (II grupė), per parą suėdė 3,9 % mažiau pašarų negu kontrolinės. Trečios grupės kiaulių (2 ml/l probiotiko) pašarų sunaudojimas per parą mažai tesiskyrė nuo kontrolės. Virš 120 dienų amžiaus tiriamųjų

4 lentelė. Pašarų sunaudojimas Table 4. Feed consumption			
Rodikliai Item	Grupės Groups		
	I (n = 12)	II (n = 12)	III (n = 12)
Pašarų sąnaudos kiaulei per parą kg: Daily feed consumption per pig, kg:			
60–90 dienų amžiuje at 60–90 days of age	0,77	0,84	0,84
91–120 dienų amžiuje at 91–120 days of age	1,81	1,74	1,82
virš 120 dienų amžiaus over 120 days of age	2,94	2,91	2,95
per visą bandymo laiką during the trial	2,20	2,18	2,18
Pašarų sąnaudos 1 kg prieaugio kg: Feed consumption per kg gain, kg:			
60–90 dienų amžiuje at 60–90 days of age	2,78	2,77	2,64
91–120 dienų amžiuje at 91–120 days of age	2,64	2,52	2,45
virš 120 dienų amžiaus over 120 days of age	3,42	3,32	3,50
per visą bandymo laiką during the trial	3,19	3,10	3,16

grupių kiaulės, gavusios probiotiko, per parą suėdė beveik tiek pat pašarų, kiek ir kontrolinės. Analogiškai pašarų sunaudojimo per parą rezultatai gauti ir per visą bandymo laiką.

Bartkevičiūtės ir kt. [2], Richter ir kt. [21, 22] duomenimis, probiotikų panaudojimas kiaulėms pašarų ėdamumui taip pat esminės įtakos neturėjo. Atlikto bandymo metu probiotikas pagerino kiaulių pašarų suėdimą per parą (9,1 %) 60–90 dienų amžiaus laikotarpyje. Büttner ir Oster [4] nurodo, jog probiotikas *BioPlus 2B* netgi 3,4 % sumažino kiaulių pašarų ėdamumą. Keegan ir kt. [14] į kiaulių pašarus įterpę probiotiko *BioPlus 2B*, gavo 0,3–0,8 % mažesnį pašarų suėdimą per parą. Kiti probiotiniai preparatai – *LactoSacc*, *BioSaf bei Yast Plus* – pašarų ėdamumui reikšmingo poveikio neturėjo.

Skerdenos kokybė. Atlikus kontrolinį kiaulių skerdimą, paaiškėjo, jog antros ir trečios grupių kiaulių, gavusių atitinkamai 1 ml/l ir 2 ml/l vandenyje suaktyvinto probiotiko, skerdenos svoris ir išėiga, skerdenos bei bekono puselės ilgis iš esmės nepakito, lyginant su kontrole (5 lentelė). Tiek I, tiek II ir III grupių kiaulių lašinių storis ties ketera, 6–7 ir paskutiniuoju šonkauliais mažai tesiskyrė.

5 lentelė. Skerdenos kokybė Table 5. Carcass quality			
Rodikliai Item	Grupės Groups		
	I (n = 10)	II (n = 11)	III (n = 11)
	M ± m	M ± m	M ± m
Skerdenos svoris kg Carcass weight, kg	82,93 ± 3,329	86,93 ± 3,333	84,15 ± 3,534
Skerdenos išėiga kg Dressing percentage, %	70,58 ± 1,312	71,06 ± 1,211	70,67 ± 1,173
Skerdenos ilgis cm Carcass length, cm	97,07 ± 0,846	97,09 ± 0,500	97,43 ± 0,835
Bekono puselės ilgis cm Half carcass length, cm	83,02 ± 0,879	82,36 ± 0,444	83,89 ± 0,998
Lašinių storis mm: Backfat thickness, mm:			
ties ketera at withers	30,80 ± 1,446	28,56 ± 0,572	29,22 ± 1,489
ties 6–7 šonkauliais at 6–7th rib	16,57 ± 1,378	16,73 ± 1,072	18,02 ± 1,481
ties paskutiniu šonkauliu at last rib	13,24 ± 0,974	13,67 ± 0,697	12,90 ± 0,914

Atlikto bandymo rezultatai beveik sutampa su Büttner ir Oster [4], Richter ir kt. [22] tyrimų duomenimis. Minėti autoriai kiaulių racione panaudoję probiotikus, taipogi nenustatė esminio poveikio skerdenos rodikliams, tik 0,9–2,7 % padidėjo raumeningumas.

Mėsos ir lašinių cheminiai bei fiziniai rodikliai. Tyrimų duomenimis, į pašarus įterpus vandenį aktyvuoto (1 ml/l – II grupė bei 2 ml/l – III grupė) probiotiko, esminio poveikio mėsos cheminei sudėčiai nenustatyta, lyginant su kontrole (6 lentelė). Antros bei trečios grupių kiaulių mėsos pH, vandens rišlumas mažai skyrėsi nuo kontrolinių, nors ir pastebima tendencija, jog šiek tiek (2,19–2,27 %) sumažėja virimo nuostoliai, tačiau skirtumai statistiškai nepatikimi. Nustatyta, kad III grupės kiaulėms panaudojus 2 ml/l probiotiko, išryškėjo lašinių hidrolizės skaičiaus mažėjimo tendencija (5,1 %; $P = 0,096$), lyginant su kontrolinėmis. Tačiau antros grupės (1 ml/l probiotiko) kiaulių minėtasis lašinių rodiklis mažai tesiskyrė nuo kontrolinių. Probiotikas neturėjo esminės įtakos lašinių lydymosi temperatūrai.

6 lentelė. Mėsos ir lašinių cheminiai bei fiziniai rodikliai Table 6. Physicochemical indicators for meat and fat			
Rodikliai Item	Grupės Groups		
	I (n = 4)	II (n = 4)	III (n = 4)
	M ± m	M ± m	M ± m
Ilgiausiasis nugaros raumuo (<i>M. longissimus dorsi</i>) <i>M. longissimus dorsi</i>			
Sausosios medžiagos % Dry matter, %	25,55 ± 0,181	25,11 ± 0,207	25,72 ± 0,516
Baltymai % Protein, %	22,02 ± 0,451	22,36 ± 0,264	22,28 ± 0,443
Riebalai % Fat, %	1,55 ± 0,264	1,44 ± 0,402	1,70 ± 0,284
Pelenai % Ash, %	1,11 ± 0,027	1,00 ± 0,060	1,10 ± 0,023
pH	5,40 ± 0,068	5,55 ± 0,070	5,37 ± 0,069
Vandens rišlumas % Water binding capacity, %	54,31 ± 2,293	56,91 ± 1,907	54,03 ± 1,310
Virimo nuostoliai % Cooking losses, %	45,12 ± 0,496	42,93 ± 1,145	42,85 ± 1,392
Lašiniai Fat			
Lydimosi temperatūra °C Melting temperature, °C	39,05 ± 0,723	37,15 ± 2,240	39,95 ± 0,532
Hidrolizės skaičius Number of hidrolisis	20,55 ± 0,412	19,55 ± 0,662	19,50 ± 0,337

Panašius rezultatus yra nustatę Bartkevičiūtė ir kt. [2] bei Vaičiulaitienė ir kt. [27]. Autorių duomenimis, probiotikų *Bonvital* ir *Yasture* priedas kiaulių pašaruose mėsos cheminei sudėčiai bei fiziniams rodikliams esminės įtakos neturėjo.

IŠVADOS

1. Į penimų kiaulių kombinuotuosius pašarus įterpus 1 ml/l ir 2 ml/l vandenyje aktyvuoto skysto probiotiko, įtakos augimo intensyvumui nenustatyta.
2. Probiotiko panaudojimas 0,9–2,8 % sumažino pašarų sąnaudas kilogramui priaugti.
3. Minėtasis priedas neturėjo reikšmingo poveikio pašarų suėdimui per parą.
4. Kiaulėms panaudojus probiotiką, skerdenos kokybės, mėsos ir lašinių cheminių bei fizinių rodiklių pokyčių dėsningumų nenustatyta.

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EFFECT OF LIQUID PROBIOTIC ON PIG PRODUCTIVITY AND MEAT QUALITY

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SUMMARY

A trial involving Lithuanian White × Norwegian Landrace × Pietrain and Lithuanian White × Norwegian Landrace × Swedish Yorkshire crossbred pigs was conducted at the Institute of Animal Science of the Lithuanian University of Health Sciences with the aim to investigate the use of a liquid probiotic in the diets for fattening pigs. All groups of pigs were fed twice daily with dry compound feeds. However, the treated pigs were additionally given a liquid probiotic composed of these bacterium cultures *Bacillus subtilis*, *Bifidobacterium animalis*, *Bifidobacterium bifidum*, *Bifidobacterium longum*, *Lactobacillus acidophilus*, *Lactobacillus bulgaricus*, *Lactobacillus casei*, *Lactobacillus delbrueckii*, *Lactobacillus fermentum*, *Lactobacillus plantarum*, *Lactococcus diacetylactis*, *Lactococcus lactis*, *Rhodopseudomonas palustris*, *Saccharomyces cerevisiae*, *Streptococcus thermophilus*. It was activated using drinking water (1 ml/l for Group II and 2 ml/l Group III) and introduced in the diets for treated pigs before feeding.

The results of the trial indicated that the use of the probiotic in the diets for fattening pigs had no significant effect on the growth rate of pigs. Due to the probiotic used feed consumption per kg gain was by 0.9–2.8 % lower, however the difference was not significant. Also, application of the probiotic had no significant influence on the quality of carcasses and physicochemical indicators of meat and fat in comparison with the control group of pigs.

Keywords: probiotic, pig growth, feed consumption, carcass quality, chemical composition of meat

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ВЛИЯНИЕ ЖИДКОГО ПРОБИОТИКА НА ПРОДУКТИВНОСТЬ СВИНЕЙ И КАЧЕСТВО СВИНИНЫ

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РЕЗЮМЕ

В Институте животноводства Литовского университета наук здоровья провели опыт на помесях Литовской белой × Норвежских ландрасов × пьетренов и Литовской белой × Норвежских ландрасов × Шведских йоркширов с целью выяснения использования влияния жидкого пробиотика в кормлении откормочных свиней. Свиней всех групп кормили два раза в день сухими комбикормами. Но свиньи подопытных групп еще получили жидкий пробиотик, составленный из культур бактерий *Bacillus subtilis*, *Bifidobacterium animalis*, *Bifidobacterium bifidum*, *Bifidobacterium longum*, *Lactobacillus acidophilus*, *Lactobacillus bulgaricus*, *Lactobacillus casei*, *Lactobacillus delbrueckii*, *Lactobacillus fermentum*, *Lactobacillus plantarum*, *Lactococcus diacetylactis*, *Lactococcus lactis*, *Rhodopseudomonas palustris*, *Saccharomyces cerevisiae*, *Streptococcus thermophilus*. Его активизировали питьевой водой (1 мл на 1 л для I группы и 2 мл на 1 л для II группы) и вводили в корма свиней подопытных групп перед кормлением.

По данным исследований при включении в корма для откормочных свиней водой активизированного (1 и 2 мл на 1 л) пробиотика, на интенсивность роста существенного влияния не установлено. Эта добавка на 0,9–2,8 % снизила затраты кормов на 1 кг прироста, но на поедаемость кормов значительного влияния не имела. При использовании с водой пробиотика, качество туши, мяса и сала свиней мало отличались от контроля.

Ключевые слова: пробиотик, рост свиней, затраты кормов, качество туши, химический состав мяса

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POJŪČIŲ JAUTRUMO ĮTAKA VERTINANT ARKLIŲ NERVINĮ TIPĄ IR BŪKLĘ

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SANTRAUKA

Šiuo darbu buvo siekta sukurti arklių augintojams bei specialistams skirtą arklių elgsenos tyrimų metodiką. Buvo analizuojama su arklių elgsena ir jos tyrimais susijusi literatūra, konsultuotasi su arklininkystės specialistais-praktikais. Parengta metodika buvo išbandyta trijuose šiaurės Lietuvos arklių veislynuose su žemaitukų ir jojamųjų (Lietuvos jojamųjų, Baltijos hanoverių, grynakraujų jojamųjų) veislių arkliais. Tyrimų metodika yra paremta penkių arklio pojūčių (skonio, uoslės, klausos, regos, lytėjimo) jautrumo įvertinimu, naudojant netikėtus dirgiklius arkliui įprastoje aplinkoje. Ją sudaro šešių testų kombinacija. Kiekvienas arklys yra testuojamas individualiai. Kiekvieno testo rezultatai vertinami penkių balų sistemoje. Arklys po šešių testų gali minimaliai surinkti 6 balus, maksimaliai – 30 balų. Aukščiausiu balu vertinamas arklys, kurio reakcija į netikėtą dirgiklį per 5 s būna teigiama, arklys nepraranda pusiausvyros ir nebūna abejingas ar baikštus. Iš instinktyvių jauno arklio reakcijų ir rezultatų suvestinės galima spręsti apie įgimtas aklio savybes, jo nervinės veiklos tipą (temperamentą), o vyresnių arklių – apie nervinės veiklos būklę, jos pažeidimus. Iš atliktų bandomųjų testavimų trijose bandose paaiškėjo, kad metodikos dėka galima nustatyti ne tik nervinės veiklos pobūdį, bet ir konkrečios bandos gerbūvio lygį bei atskiros arklio būklę toje bandoje. Bandose tirti arkliai beveik visi atitiko labai stipraus ir stipraus nervinio tipo arba būklės kriterijus bei pakankamai gerą arklių gerbūvio lygį. Tyrimai bus tęsiami su skirtingų bandų ir amžiaus grupių arkliais.

Raktažodžiai: arklių elgsena, pojūčių jautrumas, nervinės veiklos tipas, metodika

IVADAS

Arklys ypatingas tuo, kad aplinką mato maždaug 350 laipsnių, o jo reakcija yra penkis kartus greitesnė nei žmogaus, uoslė ir klausa jautresnė nei šuns [15]. Žmonės dažnai nesusimąsto apie skirtumus tarp savęs ir arklio, klaidingai interpretuoja jų reakcijas ir elgseną. Nors arklio kūno kalba nuolat duoda naudingos informacijos apie tikrą jo emocinę būseną, bet praktikoje susiduriama su faktais, kai augintojų, trenerių, raitelių neišmanymas, arklio poreikių nepaisymas žaloja arklius, kuria problemas jų laikytojams. Iki šiol Lietuvoje daugiau dėmesio skiriama arklių eksterjero ir darbingumo rodiklių vertinimui. Iš bendros arklių panaudojimo kultūros matyti, kad pamirštama, kokią svarbią praktinę reikšmę turi arklio temperamentas, ir kad nustatant arklio veislinę vertę arba bent jau darbo pobūdį, būtina į jį atsižvelgti. Temperamentas – tai įgimtas arklio reakcijos pobūdis į išorinius dirgiklius. Jis pasireiškia dirginamųjų ir slopinamųjų procesų jėga, jų pusiausvyra ir judrumu. Tyrimais nustatyta [3, 4, 6, 8, 10–13], kad nuo temperamento priklauso ne tik arklio elgesys, jo paklusnumas žmogui, bet, tam tikra dalimi, ir jo darbingumas.

Pastaraisiais metais vis daugiau mokslininkų domisi arklių reakcija į baimę sukeliančius faktorius [1, 2, 7, 9, 10]. Bandoma įvertinti, kas turi didesnę įtaką arklių reakcijai – genetika ar treniruotumas, amžius, kiti faktoriai. Atliekant tokius tyrimus užsienio šalyse [1, 2, 10], atskleidžiamos įdomios ir svarbios tendencijos. Pavyzdžiui, Švedijos mokslininkė M. C. Lundin drąsiai teigia, kad arklių genetika turi didesnę reikšmę jų reakcijai į baimę sukeliančius faktorius nei treniravimas [10]. J. W. Christensen (2005) nustatė, kad vizualinis ir garsinis stimulai sukelia arkliams didesnę fiziologinę reakciją (padažnėja širdies plakimas) nei kvapo stimulus. Būtent Švedijoje elgsenos stebėjimai dažniausiai derinami su fiziologiniais tyrimais, tokiais kaip širdies plakimo dažnis [1, 2, 9, 11, 12] ir pan. Reikia pažymėti, kad analizuotuose moksliniuose tyrimuose buvo naudoti tik pakankamai nepavojingi stimulai (kamuoliukai, šlamantys maišeliai, burbulai, kelio ženklai, žaislai ir pan.), iššaukiantys įvairaus laipsnio arklio atsitraukimo reakcijas, pagal kurių intensyvumą buvo sprendžiama apie arklio temperamentą [1, 2, 4–8].

Be neigiamų, baimę ar atsargumą keliančių dirgiklių, tyrimuose yra naudojami ir teigiami arba neutralūs stimulai bei jų kombinacijos. Teigiamas stimulus beveik visada sukelia arklio susidomėjimą, skatina prieiti. Dažniausiai tam naudojamas įprastas pašaras arba mėgstami skanumynai (avižos, duona) ir stebima, koku laipsniu neigiamas dirgiklis nuslopina teigiamą stimulą. Tokie bandymai atskleidžia tam tikras arklio psichines savybes, apibūdina jo temperamentą [9, 10, 13]. Švedijos mokslininkai įsitikinę, kad neutraliu stimulu (tai gali būti įvairūs iki tol arkliui nematyti objektai) galima atskleisti tokias arklio savybes, kaip smalsumas, pasitikėjimas žmogumi [10, 12]. Arklio reakcija į neįprastą, iki tol jam nematytą objektą yra svarbus informacijos šaltinis, daug pasakantis apie tiriamąjį individą.

Mūsų tikslas buvo, remiantis turimomis žiniomis bei praktika, sukurti praktišką arklių elgsenos testavimo metodiką, kuria galėtų naudotis ir patys arklių augintojai, veislininkystės specialistai.

TYRIMŲ SĄLYGOS IR METODAI

Tyrimai atlikti trijuose šiaurės Lietuvos veislynuose su žemaitukų ir jojamųjų [Lietuvos jojamųjų (LJ), Baltijos hanoverių (BH), grynakraujų jojamųjų (GrJ)] veislių arkliais. Tirti arkliai buvo apvedžioti, dauguma jų – treniruojami sportui arba naudojami veislei ir turizmui.

Testavimo sąlygos: arkliui įprasta aplinka, pakankamai erdvės arkliui judėti, arti testuojamo arklio nėra kitų arklių ar objektų, kurie trukdytų arkliui susitelkti į testuotoją, arkliui pažįstamų žmonių pagalba atliekant testus.

Testavimui naudotos priemonės: Rubiko kubas, duonos riekės, cukrus, druska, eukalipto aliejus, medinis skalbinių segtukas, barškutis ir plona balta plastiko plėvelė (2×3 m). Testuotojas turi užrašų knygutę, kartais jo pagalbininkas – filmavimo kamera.

Testuojamų arklių amžius: testuoti įvairaus amžiaus ir keturių veislių iki šiol tokiu būdu netestuoti arkliai po rytinio šėrimo, 10–12 val.

Tyrimų metodiką sudaro šeši testai. Kiekvienas arklys testuojamas individualiai. Kiekvieno testo rezultatai vertinami penkių balų sistemoje. Kiekvienas arklys po šešių testų gali minimaliai surinkti 6 balus, maksimaliai – 30 balų. Aukščiausiu balu vertinamas arklys, kurio reakcija į netikėtą dirgiklį per 5 s būna teigiama, pozityvi, arklys nepraranda vidinės pusiausvyros ir nebūna abejingas ar baikštus.

Pirmas metodinis testas – „Neįprastas objektas“. Šiuo testu nustatoma bendra arklio emocinė būsena, jo gerovės lygis. Po šio testo paaiškėja, ar įmanoma su šiuo arkliu vykdyti kitus testus, nes į neįprastą objektą nereaguoja sužaloti, psichologiškai palaužti, sergantys, išsekę arkliai. Sveiki, gerai auginami arkliai į šį testą reaguoja teigiamai.

Pirmo metodinio testo sudarymui panaudota informacija iš Welfare Monitoring System – Assessment protocol for horses. Version 2.0. Report number 569. Wageningen UR Livestock Research. 2011. P. 39–40 [14].

Metodinis testo „Neįprastas objektas“ aprašymas:

1. Vienas arklys įprastoje jo buvimo vietoje – garde, aptvare, ganykloje, kur yra pakankamai vietos laisvai judėti.
2. Prie arklio testuotojas prieina iš priekio, sustoja apie 2 m atstumu nuo arklio, rankoje už nugaros laikydamas Rubiko kubą.
3. Testuotojas ranką su delno apačioje esančiu kubu (arklys dar jo nemato) ištiesia horizontaliai link arklio.
4. Testuotojas apsuka ranką delnu į viršų, demonstruodamas Rubiko kubą arkliui.
5. Stebi arklio elgesį ir jį po to aprašo užrašuose.

Nors kiekvieno arklio reakcija apibendrinama penkiabalėje sistemoje, tačiau svarbu, kad išliktų išsamūs kiekvieno individualaus arklio testo aprašymai. Iš arklio elgsenos niuansų bus galima tiksliau įvertinti jo nervinės veiklos tipą, dirbant su arkliu žinoti jo silpnąsias ir stipriąsias puses, išsaugoti informaciją apie nevienodą jo atskirų pojūčių jautrumą.



1 pav. Neįprasto objekto testas

Fig. 1. Novel object test

Arklio reakcijos į Rubiko kubą (Testas Nr. 1 „Neįprastas objektas“) vertinimas:

1. Penki balai – arklys tuojau pat ištiesia kaklą ir žengia artyn, kad paliestų kubą, ir paliečia jį per penkias pirmąsias sekundes.
2. Keturi balai – arklys atsargiai pajuda į priekį ar ištiesia kaklą, kad patyrinėtų objektą uostant, bet iš karto neliečia kubo; galiausiai žengia į priekį ir paliečia, bet jau praėjus daugiau kaip 5 sekundėms.
3. Trys balai – arklys neištiesia kaklo priekin, nežengia pirmyn, lieka neutralus objekto atžvilgiu.
4. Du balai – arklys ramiai nusuka galvą ar visą kūną nuo objekto.
5. Vienas balas – arklys išsigąsta objekto ir staigiai atšoka šalin.

Antras metodinis testas – „Saldu–sūru“. Šis testas skirtas nustatyti arklio skonio pojūčio jautrumą.

Testo Nr. 2 „Saldu–sūru“ metodinis aprašymas:

1. Arkliui apsipratus su testuotoju, šis (įprastoje arkliui vietoje) ištiesia ranką su duonos rieke, apibarstyta cukrumi (maždaug šaukštas cukraus) ir stebi arklio reakciją.
2. Testuotojas tuojau po duonos su cukrumi paduoda arkliui antrą riekę duonos, tik šį kartą apibarstytą druska, ir stebi arklio reakciją.

Šis testas reikalauja testuotojo atidumo, fiksuojant ne vien lūpų ar kūno judesius, bet ir sekant arklio mimikas, niuansus, akių išraišką.

Arklio reakcijos į skirtingus skonius (Testas Nr. 2) vertinimas:

1. Penki balai – arklys abi duonos riekes ramiai siekia būti anksčiau kaip per 5 sekundes, ir viską suėda. Arklio akių ir mimikos judesiai aiškiai rodo, kad arklys skiria skonius, bet vienodai gerai juos priima.

2. Keturi balai – arklys siekė riekių 5 s bėgyje, bet kažkuriam vienam skoniuui teikė pirmenybę, o kitokio skonio ėdė nenoriai arba abi riekes suėdė neparodydamas skirtumo, neišreikšdamas to mimika ar judesiais.
3. Trys balai – arklys godžiai griebia riekę, bet ją išmeta ant žemės ar į lovį, uostinėdamas vėliau nei per 5 s vis dėlto suėda.
4. Du balai – arklys atsargiai, baimingai paliečia riekę, atsitraukia arba ją numeta, nesuėda net praėjus 5 sekundėms.
5. Vienas balas – arklys atšoka nuo byrančio cukraus ar druskos, ir per 5 s nebeprieina artyn.



2 pav. Skonio testas

Fig. 2. Testing taste

Trečias metodinis testas – „Neįprastas kvapas“. Šiuo testu siekiama išsiaiškinti arklio uoslės jautrumą ir jo reakcijas į dar nejaustą kvapą.

Testo Nr. 3 „Neįprastas kvapas“ metodinis aprašymas:

1. Testas atliekamas iš karto po testo Nr. 2. Testuotojas po duonos su druska arkliui duoda riekę duonos, ant kurios užlašinta 15 lašų eukalipto eterinio aliejaus.
2. Stebėti arklio reakciją.

Arklio reakcijos į neįprastą kvapą (Testas Nr. 3) vertinimas:

1. Penki balai – arklys iš karto iki 5 s pajuntą neįprastą kvapą, bet jis jo neatbaido, priešingai, arklys nori ragauti tokios duonos.
2. Keturi balai – arklys rodo flemeno reakciją – išriečia viršutinę lūpą ir įtraukia kvapą giliau. Ir tik tada ragauja duoną.
3. Trys balai – arklys parodo, kad jaučia kvapą (uostinėja orą, kiša artyn snukį),

tačiau tokią duoną liečia atsargiai, tyrinėdamas, kol pagaliau, vėliau kaip per 5 s, vis dėlto paragauja.

4. Du balai – arklys parodo, kad jaučia kvapą, bet jis jam nepatinka arba nesudomina, tokios duonos jis neragauja.
5. Vienas balas – arklys šnarpščia, baidosi šio kvapo, metasi šalin ir net neketina ragauti.



3 pav. Neįprasto kvapo testas

Fig. 3. Test for novel smell



4 pav. Neįprasto kvapo testas gali iššaukti flemeno reakciją

Fig. 4. Testing novel smell might cause

Ketvirtas metodinis testas – „Jautrumas skausmui“. Jis paremtas lietimo pojūčio jautrumo nustatymu.

Testo Nr. 4 „Jautrumas skausmui“ metodinis aprašymas:

1. Testas atliekamas arkliui įprastoje vietoje su galimybe laisvai judėti.
2. Medinį skalbinių segtuką arkliui į ausį (netoli smaigalio) įsega jam pažįstamas žmogus (arklininkas, treneris, šeimininkas ar pan.). Taip išvengiama šalutinio dirgiklio (nepažįstamo žmogaus – testuotojo) sąlyčio su arkliu ir jo reakcijos į šį žmogų, o ne į norimą šiuo atveju dirgiklį – pamažu skausmą keliantį segtuką.
3. Testuotojas stebi ir užrašo arklio reakciją.



5 pav. Jautrumo skausmui testas

Fig. 5. Pain susceptibility test

Arklio jautrumo skausmingam lietimui (Testas Nr. 4) vertinimas:

1. Penki balai – arklys su įsegtu į ausį segtuku išlieka ramus, nesimuisto, nenusipurto segtuko per 5 s.
2. Keturi balai – arklys muistosi, karmo ausimis, rodydamas, kad jam nemalonus šis pojūtis, bet per 5 s segtuko nenupurto.
3. Trys balai – arklys jaučia stiprėjančią segtuko veržimą, bet iš pradžių nesupranta, kas vyksta, žiūri į žmogų laukdamas, kad jis pagelbėtų. Vėliau kaip per 5 s nusipurto ir išmeta segtuką.
4. Du balai – arklys ramiai, bet ryžtingai iš karto nusipurto segtuką per 5 s.
5. Vienas balas – įsegus segtuką metasi nuo žmogaus į šalį, susinervina ir per 5 s nusipurto segtuką.

Penktas metodinis testas – „Plėvelės testas“. Šiuo testu siekiama nustatyti instinktyvią arklio reakciją į neįprastą paklotę. Testas parodo, kaip arklio regos ir kanopų centrinei nervų sistemai siunčiami signalai gali įtakoti jo elgseną. Šis testas gana informatyvus, su plačiausiu galimų reakcijų diapazonu.

Testo Nr. 5 „Plėvelės testas“ metodinis aprašymas:

1. Testui naudojama plona, beveik permatoma, balto plastiko plėvelė, 2 x 3 m išmatavimų.
2. Plėvelė ištiesiama ant lygaus paviršiaus arkliui įprastoje vietovėje – kieme prie arklidžių, mociono aikštelėje ar pan. Aplinkui neturi būti kitų dirgiklių, kitų arklių. Plėvelė prispaudžiama žemėmis, akmenukais, kad neplazdėtų, nešnarėtų, todėl testuoti geriausia ramią dieną.
3. Arkliui pažįstamas žmogus (arklininkas, treneris ar kt.) veda arklį su pavadžiu arba kordu link vietos, kur paklota plėvelė.
4. Žmogus turi eiti ramiai, pasitikinčiai ir vesti arklį per plėvelę.
5. Arklių vedantis žmogus neturi naudoti prieš arklį jokios prievartos, juo labiau papildomų priemonių, tik geranorišką žodinį paraginimą ir vedimą.
6. Testuotojas stebi iš šono ir pažymi arklio elgesį viso išvedimo metu.



6 pav. Arklių reakcija į vedimą per plėvelę
Fig. 6. Response to walking on a plastic sheet

Testo Nr. 5 „Plėvelės testas“ vertinimas:

1. Penki balai – arklys pereina plėvelę nesustodamas, nė kiek neišsigandęs, gali truputį aukščiau kelti kojas.
2. Keturi balai – sustoja prieš pat plėvelę, paragintas pereina, bet akivaizdžiai keldamas kojas.

3. Trys balai – sustoja prieš plėvelę, šiek tiek išsigąsta, gali žengti atgal, paragintasi ryžtasi žengti ir perbėga plėvelę risčia ar šuoliais kuo greičiau ir kuo mažiau liečiantis kojom prie jos arba bando peršokti kaip kliūtį.
4. Du balai – sustoja dar gerokai prieš plėvelę, stipriai įsispiria, atsisako eiti, atkakliai bando eiti atgal, tačiau išlieka gana ramus, plėvelės nepereina.
5. Vienas balas – arklys dar prieš prieidamas arčiau plėvelės metasi atgal, smarkiai traukia pavadį, nori pabėgti, baidosi, taip ir nepereina plėvelės.

Šeštas metodinis testas – „Neįprastas garsas“. Testas skirtas nustatyti arklio reakciją į neįprastą garsinį dirgiklį, arklio klausos pojūčio jautrumo įtaką jo elgsenai.

Testo Nr. 6 „Neįprastas garsas“ metodinis aprašymas:

1. Testas atliekamas arkliai įprastoje aplinkoje be pašalinių dirgiklių (kitų arklių, triukšmo ir t. t.).
2. Testui atlikti naudojamas barškutis – plastmasiniame indelyje esantys žirnio dydžio plastmasiniai rutuliukai.
3. Testuotojas atsistoja maždaug 2 m prieš arklį. Reikia palaukti, kol arklys nustos kreipti dėmesį į testuotoją, apsipras su jo buvimu.
4. Kuo mažiau judėdamas (kad nesukeltų vizualinio stimulo vietoje garsinio) testuotojas pabarškina barškučiu.
5. Stebi arklio reakciją į netikėtą ir neįprastą garsą.



7 pav. Neįprasto garso testas
Fig. 7. Testing for unusual sounds

Arklio reakcijos į Testą Nr. 6 „Neįprastas garsas“ vertinimas:

1. Penki balai – arklys nė kiek neišsigąsta, garsas jį sudomina ir jis iš karto per 5 s prieina artyn, nori paliesti barškutį.
2. Keturi balai – arklys garso neišsigąsta, bet ir neina artyn, lieka atsargiai stebėti savo vietoje.

3. Trys balai – nuo garso arklys krūpteli, atšoka, bet per 5 s susiorientuoja ir reakcija iš baimės pereina į susidomėjimą.
4. Du balai – arklys išsigąsta, pabėga arba neramiai trypdamas kojomis, karpydamas ausimis rodo, kad jam tai nepatinka, bet kūnas nedreba, arklys nepanikuoja, net kažkiek domisi garso šaltiniu iš tolo.
5. Vienas balas – arklys labai staigiai ir stipriai išsigąsta, dreba, nori pasislėpti, susijaudinęs, sunkiai nusiramina.

Visų šešių testų rezultatų vertinimas. Visų kiekvieno arklio testų rezultatai sumuojami ir, priklausomai nuo arklio amžiaus, nustatomas jo nervinės veiklos tipas arba būklė. Remiantis sudaryta metodika ir pirminiais tyrimais, siūloma arklių nervinės veiklos (temperamento) tipus skirstyti ir žymėti tokia tvarka (1 lentelė):

1. Labai stiprus arklio nervinės veiklos tipas, – kada visų testų metu surenkama balų suma yra lygi 25–30 balų, žymima raide A. Taip sutartinai pažymimas arklys, kurio testų balai yra aukšti, kuris, nepraranda vidinės pusiausvyros, pasižymi stabilia, pozityvia psichika, greita reakcija, santūriai reaguoja į neįprastus dirgiklius.
2. Stiprus arklio nervinės veiklos tipas, – kada balų suma siekia 19–24, žymimas raide B. Tai arklys, pasižymintis vidine pusiausvyra, patikimas, tačiau su lėtesne nei A tipo arklių reakcija arba turintis padidintą kurio nors pojūčio jautrumą.
3. Vidutiniškai stiprus arklio nervinės veiklos tipas, – kada balų suma siekia 13–18, žymima raide C. Tokio arklio nervinė veikla mažiau paslanki, impulsai lėtesni, jis negali greitai susiorientuoti pasikeitusiose sąlygose, todėl su jais reikia atsargumo ir švelnumo. Jų dirginamųjų procesų jėga yra didesnė už slopinamųjų procesų jėgą.
4. Silpnas arklio nervinės veiklos tipas, – kada balų suma tesiekia 7–12, žymimas raide D. Tai arkliai, turintys silpnus nervinės veiklos procesus, todėl yra nepastovaus elgesio, neįprasti dirgikliai jiems kelia baimę, jie sunkiai prisitaiko prie pakitusių sąlygų, juos sunku apmokyti ir su jais dirbti.

1 lentelė. Arklių nervinės veiklos tipų (būklės) žymėjimas

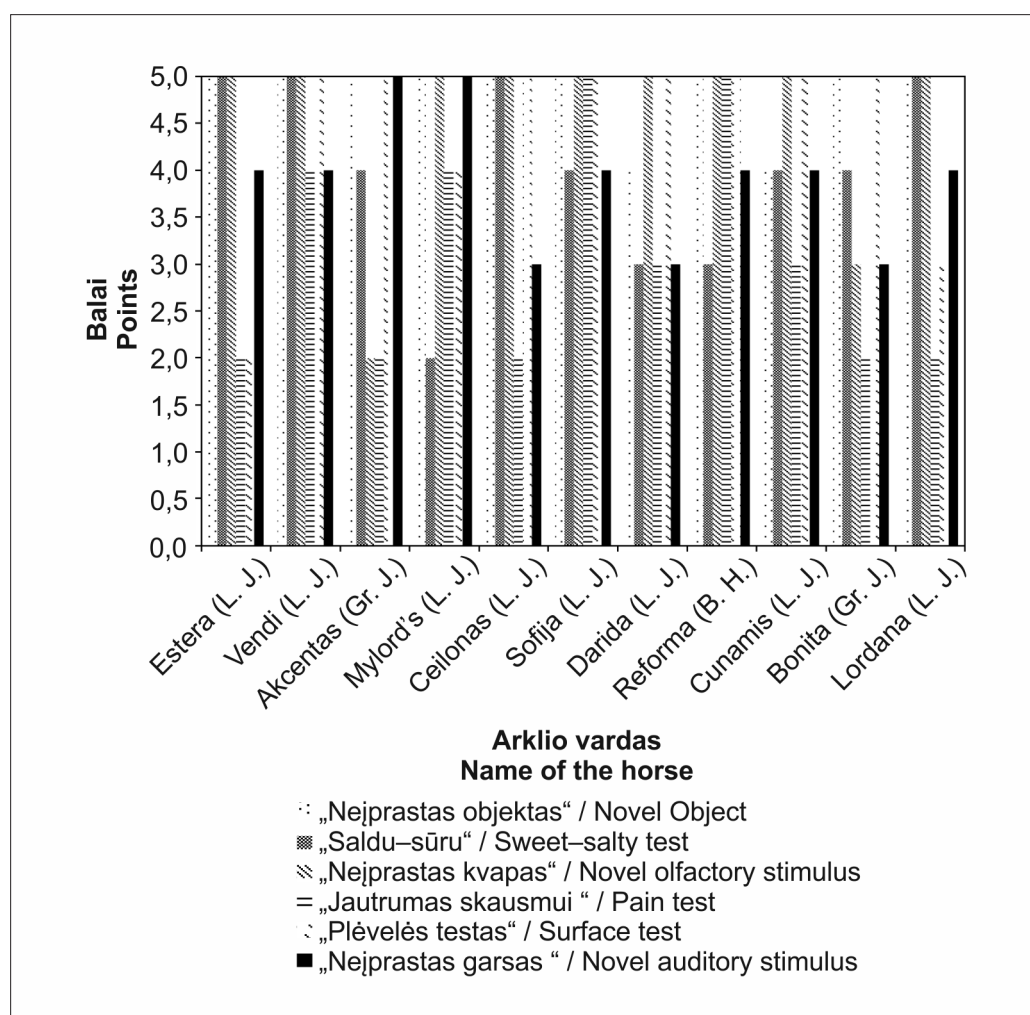
Table 1. Scores of nervous activity type for horses

Balų suma Points	Nervinės veiklos tipas (temperamentas) Nervous activity type (temperament)	Žymėjimas Score
25–30	Labai stiprus Very strong	A
19–24	Stiprus Strong	B
13–18	Vidutiniškai stiprus Of average strenght	C
7–12	Silpnas Weak	D
6	Labai silpnas Very weak	E (SOS)

5. Labai silpnas (pažeistas) nervinės veiklos tipas, – kada balų suma yra 6 balai, žymimas raide E (SOS). Šiam arkliui būtina profesionali pagalba, jo nervinė veikla yra pažeista, jis neadekvačiai reaguoja į aplinką, visi testų dirgikliai jam kelia baimę, net paniką.

TYRIMŲ REZULTATAI IR JŲ APTARIMAS

Bandomųjų tyrimų metu gauti testavimo rezultatai rodo (8–10 pav.), kad aukščiausias arklių gerbūvio lygis ir daugiausia (58,3 proc.) labai stiprios nervinės veiklos (A tipo) arklių buvo jojamųjų arklių veislyne.



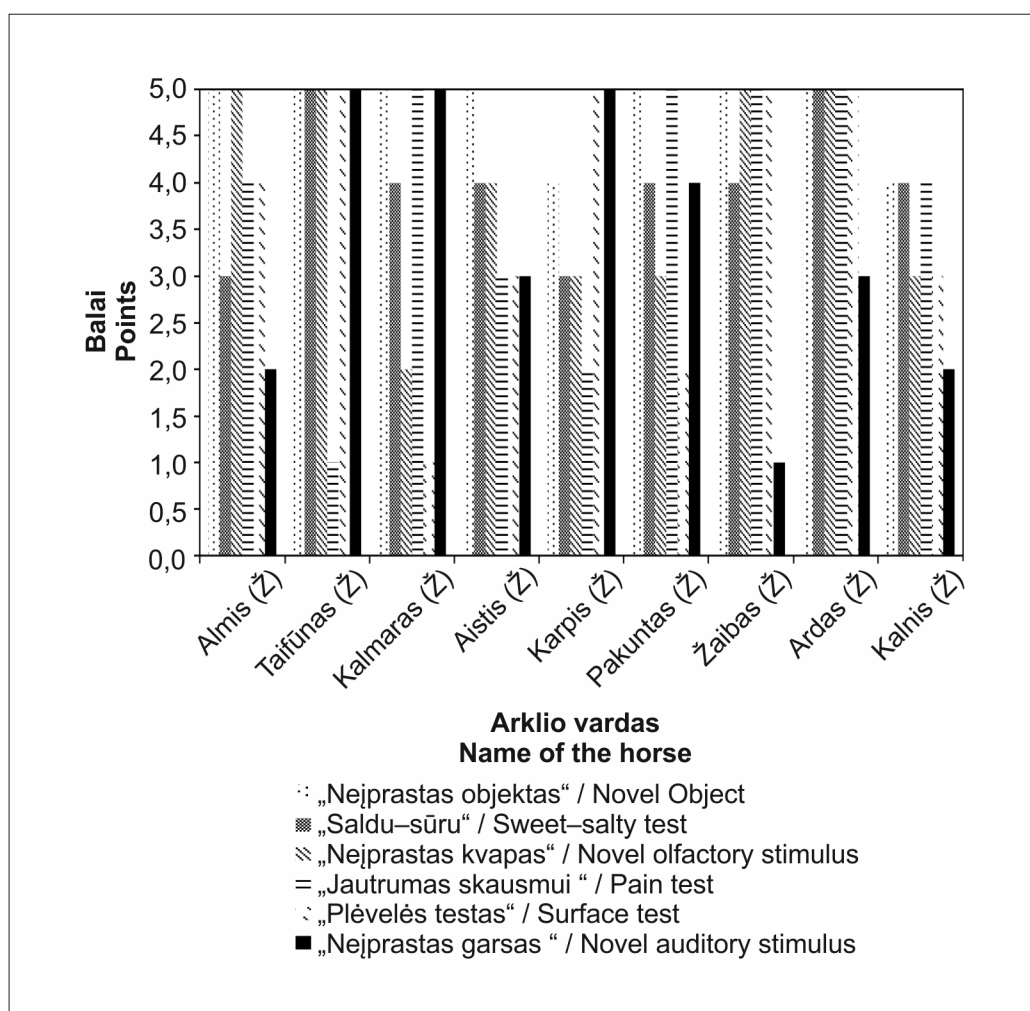
8 pav. Jojamųjų arklių testavimo rezultatai

Fig. 8. Test results for saddle horses

Pakankamai gera padėtis yra ir to paties rajono žemaitukų bandoje, kurioje tirti arkliai buvo labai stiprios ir stiprios nervinės veiklos (A ir B tipo). Kitame žemaitukų žirgyne tik viena kumelė buvo C tipo, o dauguma arklių pagal nervinės veiklos stiprumą atitiko B tipą.

Šiek tiek blogesnius antrojo žemaitukų veislyno rezultatus galėjo įtakoti turistai. Jiems yra leidžiama atvykti didelėmis grupėmis ir nedraudžiama duoti arkliams skanėstų. Tyrimo metu akivaizdžiai skyrėsi šios bandos arklių reakcija į duoną su cukrumi ir su druska. Jie labiau tyrinėjo duodamą maistą, buvo atsargesni, mažiau pasitikintys testuojant skonio pojūtį.

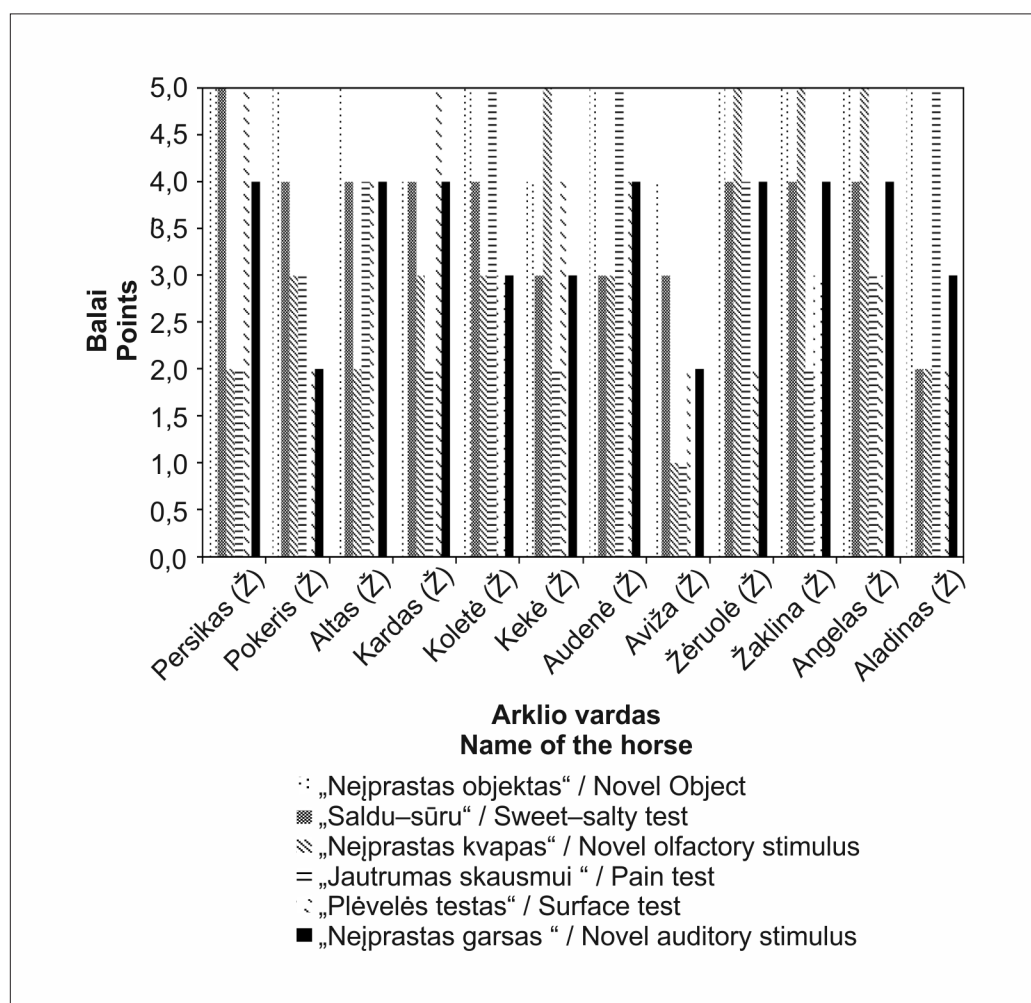
Atliktų tyrimų suvestinės parodo, su kuriuo arkliu ir su kuriuo jo pojūčiu reikės



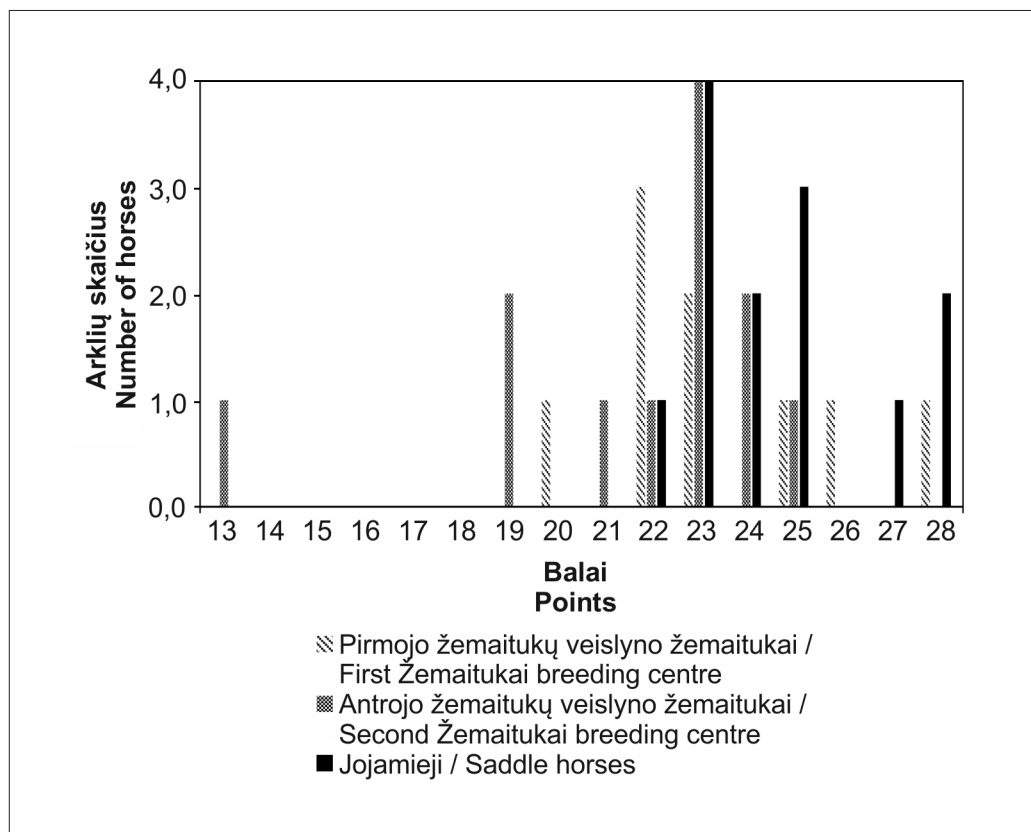
9 pav. Pirmojo žemaitukų veislyno testavimo rezultatai

Fig. 9. Test data of the first Žemaitukai breeding centre

daugiausia dirbti. Tyrimų rezultatai yra nuoroda su arkliu dirbantiems žmonėms, į ką jie turi atkreipti dėmesį, koks arklio pojūtis yra nestabilus, kur labiausiai reikia arkliui pagalbos, ties kokiomis užduotimis turi būti dirbama, formuojant teigiamus sąlyginius refleksus. Nes tiek nuo arklio fizinės būklės, tiek ir nuo nervinės veiklos pobūdžio priklauso, kokios bus arklio panaudojimo galimybės bei jo bendradarbiavimo su įvairiais žmonėmis sėkmė. Mūsų tyrimai atskleidė atvejus, kai beveik visose pozicijose stabilus ir patikimas arklys, turi pojūtį, kurį neįprastas dirgiklis „pramuša“. Tai ypač svarbu žinoti, atrenkant arklius vaikų sportui ir gydomajai žmonių terapijai. Fizinėms arklių savybėms įprastai teikiamas didesnis dėmesys tiek Lietuvoje, tiek užsienio šalyse. Tačiau šiuolaikinis mokslas vis aktyviau ieško būdų ir žinių, kurie, galbūt, leistų sukurti kokius nors



10 pav. Antrojo žemaitukų veislyno testavimo rezultatai
Fig. 10. Test data of the second Žemaitukai breeding centre



11 pav. Žemaitukų ir jojamųjų veislių arklių testavimo suvestinė
Fig. 11. Test data summary for the Žemaitukai and saddle horses

patikimus arklių temperamento, psichikos testus, padėsiančius parinkti tinkamus arklius įvairioms situacijoms ir įvairiems žmonėms (raiteliams, vaikams, hipoterapijai ir pan.).

Mūsų nuomone, arkliui tinkamiausio darbo pobūdis ar jo atranka veislei turi priklausyti nuo visų požymių vertinimo, t. y. svarbu ir genotipas, ir fenotipinės savybės – eksterjeras, judesiai, tipingumas bei tai veislei optimalūs kūno matmenys. Tačiau arklio charakterio vertinimas būtų daug naudingesnis, jei selekcininkas, prieš arklio kompleksinį vertinimą, jau turėtų nervinės veiklos testavimo rezultatus. Po nervinės veiklos testavimo rekomenduotina palikti veislei A ir B tipų arklius, nes, žiūrint iš pojūčių jautrumo taško, jie gali būti tinkami įvairiose srityse pagal tos veislės galimybes.

Dėl nervinės veiklos C tipo arklių panaudojimo turi spręsti atitinkamos veislės atskirai asmenys ar organizacijos, priklausomai nuo to, kokie veislei keliami reikalavimai, veisimo tikslai, ar yra pakankamai kvalifikuoto personalo tokių arklių apmokymui.

Silpnos nervinės veiklos arba D tipo arklių nerekomenduojama palikti veisimui jokioje veislėje, nes jie negali suprasti ir tiksliai vykdyti sudėtingesnių žmogaus komandų, sunkiai prisitaiko, gali įgyti blogų įpročių ir būti prasto darbingumo.

Prie E tipo (labai silpnos nervinės veiklos) arklių neatsitiktinai pridedamos raidės SOS, tai reiškia, kad tokiems arkliams būtina skubi pagalba. Tai dėl labai įvairių priežasčių viduje kenčiantys arkliai. Veterinarijos ir arklių specialistai turi įvertinti tokių arklių būklę ir rimtai pasikalbėti su arklių savininku, o reikalui esant, imtis griežtesnių priemonių. E tipo arklių reakcijos rodo visišką nervinės veiklos išsekimą, būtina nustatyti to priežastis. Apie šių arklių darbingumą ar veislininkystę negali būti nė kalbos, nes reikia gelbėti jų gyvybę.

Bandymuose dalyvavusių žemaitukų ir jojamųjų žirgų veislynuose silpnos ir labai silpnos nervinės būklės arklių nepasitaikė. Tai reiškia, kad visi trys žirgynai pateisina veislynų statusą, veisia stiprios nervinės veiklos arklius bei prisilaiko jų gerovės reikalavimų.

IŠVADOS

1. Parengta ir pristatoma originali arklių elgsenos tyrimų metodika nervinės veiklos tipui (arba būklei) nustatyti. Metodika paprasta naudotis, bet ji suteikia daug informacijos apie arklio pojūčius bei jų jautrumą.
2. Pagal šią metodiką atliekamais tyrimais taip pat galima atskleisti bendrą arklių bandos gerbūvio lygį ir atskiro individo būklę bandoje.
3. Bandymuose dalyvavę du žemaitukų ir vienas jojamųjų žirgų veislynas pateisina statusą, nes veisia stiprios nervinės veiklos arklius bei prisilaiko jų gerovės reikalavimų.
4. Reikalingi tolimesni įvairaus amžiaus arklių grupių ir skirtingų bandų tyrimai, po kurių galima būtų aptarti metodikos pritaikymo vertinimo sistemose tikslingumą.

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ASSESSMENT OF HORSE TEMPERAMENT AND STATE BY SENSE SUSCEPTIBILITY

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SUMMARY

The study was aimed at developing methodical guidelines for equine behavioural studies for horse breeders and specialists. The prepared methods were tested in three horse breeding centres of northern Lithuania with the horses of the Žemaitukai and saddle breeds (Lithuanian saddle, Baltic Hanoverian, Thoroughbred). The methods are based on the five horse senses (taste, smell, hearing, sight and touch) and their sensitivity assessment by using novel irritants in the habitual environment for the horse. A combination of six tests is used. Every horse is tested individually. The results of each test are scored on a five-point scale. The minimal and maximal scores for a horse after six testing's could be, respectively, 6 and 30 points. The highest score is given to the horse, the response of which to the novel irritant in 5 seconds was positive, the horse did not lose its balance, did not show indifference or fearfulness. The instinctive responses of a young horse and the data summary could be used to judge about the inherent abilities and the temperament of a horse, whereas those of an older horse could show the status of its nervous activity and damage. Experimental tests in three herds indicated that the methods allow assessing not only the type of the nervous activity, but also indicating the welfare of a specific herd and the status of an individual horse in the herd. Almost all the horses tested met the criteria for a very strong or strong nervous type or status and revealed a relatively high level of horse welfare. Further studies with the horses from different herds and of different age groups will be carried out.

Keywords: equine behaviour, sensitivity, type of nervous activity, methods

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ВЛИЯНИЕ ОСТРОТЫ ВОСПРИЯТИЙ ПРИ ОЦЕНКЕ ТИПА И СОСТОЯНИЯ НЕРВНОЙ ДЕЯТЕЛЬНОСТИ ЛОШАДЕЙ

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РЕЗЮМЕ

Цель данной работы – создать методику исследования поведения лошадей для специалистов коневодства и конных заводов. Для этого пранализировали литературу по поведению лошадей и материалы научных исследований, с помощью обращались к опытным специалистам-практикам. Подготовленная методика была испытана на лошадях жмудской и верховой (литовские скакуны, балтийские ганноверы, чистокровные рысаки) пород в трех конных заводах северной Литвы. Методика исследований основана на оценке пяти ощущений лошадей (вкус, обаяние, слух, зрение и осязание) при помощи использования неожиданных для животного стимулов в привычной для лошади обстановке. Методику составляет комбинация из шести тестов. Каждую лошадь тестировали индивидуально и полученные результаты оценивали по пятибалльной системе (минимум – 6, максимум – 30 баллов). Наивысшую оценку получала лошадь, у которой реакция на неожиданный стимул на протяжении 5 секунд была положительной (т.е. лошадь вела себя спокойно, без испуга и не потрелял равновесия в поведении). На основе сводки результатов инстинктивного поведения молодых лошадей была получена возможность делать вывод о врожденных качествах лошади, тип нервной деятельности (темперамент), а для старших лошадей – о состоянии нервной системы и ее повреждениях. На примере опытного тестирования в трех хозяйствах установлено, что при помощи методики можно определить не только вид нервной деятельности (темперамент) лошади, но и установить уровень благополучия определенного стада и состояние

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каждой лошади в нем. Надо отметить, что в обследованных стадах почти все лошади были отнесены критериям сильного типа нервной деятельности (темперамента) и соответствовали уровню хорошего благополучия стада. В дальнейшем исследования будут проведены на лошадях различных стад и возрастных групп.

Ключевые слова: поведение лошадей, ощущения, тип нервной деятельности, методика

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