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Genotypic and phenotypic parameters of Kotlenska and Tetevenska sheep breeds and opportunities for effective supporting selection

ABSTRACT OF DISSERTATION

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The dissertation work has been discussed and proposed for defense by the extended board of the Animal Husbandry Department at the Research Institute of Animal Husbandry of Troyan (RIMSA).

The dissertation consists of 134 pages, 43 tables and 22 figures. The list of cited literature contains 136 sources, of which 94 are in Cyrillic and 42 in English.

The numbering of the sections, tables and figures in the Dissertation Abstract does not correspond to those in the Dissertation.

The defense of the dissertation will take place on 04.12.2023 at 11,00 a.m. in a meeting hall № 2 at RIMSA - Troyan.

The materials related to the defense are available from the Scientific Secretary of RIMSA - Troyan and on the website of RIMSA - Troyan https://www.rimsa.eu/.

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I. INTRODUCTION

The sheep breeding of sheep in Bulgaria dates back to the time of the Thracians, as a prerequisite for this were the favourable soil and climatic conditions and the rich foot-hill and mountain pastures. Thanks to its versatile productivity, sheep farming occupies a high position in the development of Bulgarian economy.

The most successful period for Bulgarian sheep farming was the period 1980-1984, at the end of which their number reached about 11 million. There were even programs to increase them to 18-20 million. In 1984, 243,0418 tons of meat, 313,116 tons of sheep's milk and 36,158 tons of unwashed wool were produced in Bulgaria.

From time immemorial, local breeds and broods of sheep have been raised in Bulgarian mountain and foot-hill regions. Each of them has specific biological and productive features and is well adapted to the respective regions. Most of them bear the name of the region in which they are raised, for example Tetevenska, Strandzhanska, Srednostaroplaninska, Koprivshtitsa, Kotlenska, Svishtovska, Breznishka, etc. In recent years, according to the recommendations of the FAO, these breeds have been given a lot of attention, supported by subsidies, because they are very valuable as a national gene pool that must be preserved.

Tetevenska and Kotlenska are typical representatives of the autochthonous sheep breeds, adapted and raised in the mountain and foot-hill conditions of the Central Balkan Mountain, as Tetevenska breed in in the north, and Kotlenska breed in in the south.

The local (autochthonous) sheep breeds with their valuable qualities, such as endurance to harsh climatic conditions, adaptability to the area of residence and a healthy bone system, have served as the basis for the creation of a number of Bulgarian breeds, such as thin-wool North-East Bulgarian, Thracian thin-wool, Danube thin-wool, Karnobatska thin-wool, Northern Bulgarian Corriedale, South Bulgarian Corriedale, Staroplaninski Tsigai, Rhodope Tsigai and Bulgarian White Dairy Synthetic Population. Tetevenska sheep breed is one of the breeds that served as the basis for the creation of Staroplaninski Tsigai, whereas Kotlenska breed is for the creation of Rhodope Tsigai.

Created in Bulgaria over the centuries, as a result of popular selection, the autochthonous sheep breeds have proven to be the most resilient, well adapted to the soil and climatic conditions. The preservation of their gene pool is carried out with the activities, habits, customs, resources and practices characteristic of the region. The protection of biological diversity and the gene pool of plants and animals is one of the priorities of the EU. This implies active work to preserve the country's valuable genetic resources, including autochthonous sheep breeds. For the maintenance and development of these sheep in the Republic of Bulgaria, breeding organizations have been established and breeding programs have been developed for maintenance selection.

By preserving the autochthonous sheep breeds, not only their valuable gene pool is preserved, but also the traditions and cultural heritage of the inhabited regions.

In view of the authenticity, genetic diversity and gene pool of local breeds, there is a need for research, analysis, assessment of productivity, economic efficiency, as well as applied selection approaches in the preservation and future breeding of these valuable local sheep breeds for bulgaria.

II. AIM AND OBJECTIVES OF THE RESEARCH WORK

The aim of the present study is to establish the parameters of the productive traits and opportunities for effective maintenance selection of Tetevenska and Kotlenska sheep breeds.

The information obtained will enable a more correct formulation of the breeding programs and selection criteria of the breeding organizations for the respective breeds. It will help in the selection of effective maintenance breeding schemes to conserve the gene pool and prevent the extinction of these two autochthonous sheep breeds.

To fulfill the objectives of the research work, the following tasks have been assigned:

Task 1. To establish the manifestation and dynamics of the live weight trait in animals of different ages of Tetevenska and Kotlenska sheep breeds.

Task 2. To determine the exterior and establishing the exterior indices in Tetevenska and Kotlenska sheep.

Task 3. To characterize the morphology of the dermatoglyph in Tetevenska and Kotlenska sheep breeds.

Task 4. To study fertility in Tetevenska and Kotlenska ewes.

Task 5. To assess the meat productivity in Tetevenska and Kotlenska sheep breeds.

- Study on the fattening and meat-producing qualities of Tetevenska and Kotlenska lambs.
- Research on the meat quality of Tetevenska and Kotlenska lambs.

Task 6. To study milk productivity in Tetevenska and Kotlenska breeds.

- Determination of milk yield in Tetevenska and Kotlenska ewes.
- Study of the mineral and fatty acid composition of milk
- Study of the physico-chemical composition of sheep's milk and the white brine cheese produced from it from Tetevenska and Kotlenska sheep breeds.

Task 7. To determine wool yield and fleece pigmentation in Tetevenska and Kotlenska sheep breeds

Task 8. To monitor sheep farms raising Tetevenska and Kotlenska sheep breeds.

Task 9. To establish the economic efficiency of raising Tetevenska and Kotlenska sheep breeds.

III. MATERIAL AND METHODS

The research work was conducted during the period 2018-2021. It includes 395 ewes and 18 rams from purebred herds with Tetevenska breed, raised in the regions of Teteven municipality and 384 ewes and 13 rams of Kotlenska breed, bred in the area of Kotel and Sliven, as well as 96 lambs obtained in the observed farms from the regions of Teteven and Kotel.

The following studies were conducted:

Monitoring growth dynamics and individual development from parturition to completion of animal growth. The average live birth weight of lambs at birth at 3, 9, 18 months and of ewes at 2.5 years and 3.5 years was recorded.

Exterior measurements were conducted on 88 ewes aged 2.5 and 3.5 years of the studied breeds, after shearing using Lidtin's small stock for small-sized animals, Wilkens' caliper for small animals and tape accurate to 0.5cm.The average values and the variation were determined, and on their basis the exterior indices for massiveness, for stretched body,

chest index, for compactness, for superstructure and for the development of the bone system were calculated.

In order to study the fattening and meat-producing qualities of male and female lambs of Tetevenska and Kotlenska breeds, an experiment was conducted at the Experimental Base of RIMSA in the city of Troyan, with 16 animals from purebred herds in the Teteven and Kotel region. When the ewes gave birth, the offspring was weighed with an electronic scale with an accuracy of 0.1 kg. Gender and type of birth were recorded. At the age of 45 days, the lambs were weaned, weighed with an electronic scale with an accuracy of 0.1 kg and included in four groups - 2 of each breed, 4 male and 4 female lambs respectively.

The groups were formed according to the method of analogues - an equal number of males and females. The animals were raised freely in boxes on non-removable litter, in accordance with the requirements to the parameters of the living environment of sheep and goats for pasture-barn based breeding, according to Regulation No 44 OF 20 APRIL 2006 on veterinary requirements for livestock farms.

The fodder was placed in combined feeders, and the animals were fed freely with combined fodder for lambs (KF-180), certified and produced by a fodder plant in the city of Lovech, containing in 1 kg 0.84 FUG and 132.98g of PDI and ground alfalfa hay containing in 1kg 0.63 FUG and 96.53g PDI. Feed consumption was reported daily and periodically. Controlling the live weight of the lambs included in the experiment was conducted every 15 days with an accuracy of 0.1 kg.

After a 60-day fattening period, a slaughter analysis was performed. Three lambs with a live weight closest to the group average were slaughtered from each experimental group. They were slaughtered according to the requirements of Ordinance No. 22 of December 14, 2005 /To minimize the suffering of animals during slaughter or killing/.

Carcasses were cooled at a temperature of -4ºC for 24 hours, after which they were divided into two halves along the length of the spine, the left half was taken and a cut was made. The half is dissected at specific points into the following anatomical parts: neck, shoulder, chest, lumbar part, abdomen and led, after which each of them is weighed and deboned. The weight ratio of meat:bone:fat in each anatomical part was established.

The cutting of the logs was carried out according to the methodology of Zahariev and Pinkas, (1979). The weight ratio of all parts was determined and the content of meat, bones and fats was determined, as well as the ratio of bones to meat in the carcass in the individual sections. Samples were obtained from *m.Longissimus* and *m.Semimembranosus*. From the carcass of each slaughtered animal, samples were taken for chemical analysis - content of moisture, fat, proteins, collagen and mineral substances, which were examined on a Food Skan™FOSS ELEKTRIC device, in the laboratory of RIMSA – Troyan. The content of macro- and microelements, as well as the fatty acid composition of the meat of the lambs of the studied breeds, was investigated. Standard methods applied in the central research laboratory of the Faculty of Agriculture of the Trakia University of Stara Zagora were used.

Water Holding Capacity was determined according to the methodology of Grau and Hamm, (1953), pH24 – potentiometrically, tenderness – penetrometrically. The content of macro and microelements in the meat samples was determined after dry ashing and mineralization (muffle furnace at a temperature of 550°C). A salt-acid solution was prepared from the resulting ash, which was diluted to a certain volume during the determination of the individual elements.

The content of K was determined using a flame photometer (Flamon B), and the remaining elements (with the exception of P using the molybdate vanadium method -

according to Kondratenko et al., 1981) using an Atomic Absorption Spectrophotometer "Perkin - Elmer 380".

The study on the fatty acid composition of the meat was carried out by extracting the fat with methanol/chloroform, followed by thin-layer chromatography and examination of the samples with a gas chromatograph (GS - Pay Unicam 304 with a flame-ionization detector - GiD). Analyzes were performed with an ECtm WAX H2 capillary column as the carrier gas.

To determine the milking milk production, individual samples were taken from 50 ewes from Tetevenska breed and 50 ewes from Kotlenska breed. The reporting of milk yield was carried out through monthly controls from the month of April to the month of June, according to ICAR. The amount of milk and the average daily milk yield were established according to the Instruction for the control of the productive qualities and bonitization of sheep (2003).

From the samples taken, the content of dry matter, fat, dry fat-free residue, protein, lactose, casein, non-casein protein, density and titratable acidity was determined.

The physico-chemical composition of the milk was carried out with the "Milko Skan FT 120 FOSS ELECTRIC" apparatus in the laboratory of the Institute of Food and Beverage - Troyan. OF TROYAN

The content of macro and microelements in milk, as well as the content of fatty acids in it, were determined in the Central Research Laboratory of the Faculty of Agriculture at the Trakia University, according to the standard methods described above. Fat extraction of the milk samples was carried out according to the method of Roese-Gottlieb, (1973), after which the solvents were evaporated with a vacuum rotary evaporator. Fatty acid methyl esters were analyzed using a Pay-Unicam 304 gas chromatograph (GC) with a flame ionization detector (FID). Analysis was performed with an ECTM WAX capillary column (Alltech; 30 m x 0.25 mm, I.d.; 0.25 μm film) and H2 as carrier gas. The groups of fatty acids and the ratios between them were determined by calculation.

The atherogenic index was determined by the formula of Ulbricht, T. and Southgate, D., (1991) as follows:

$$AI=\frac{C12:0+4xC14:0+C16:0}{MUFAs+PUFAs}$$

where:

AI	is atherogenic index
C12:0	- lauric acid
C14:0	- myristic acid
C16:0	- palmitic acid
MUFAs	- monounsaturated fatty acids
PUFAs	- polyunsaturated fatty acids

Lipid preventive score was determined by calculation, according to the equation of Richard and Charbonnier, (1994):

LPS=TL+2xSFAs-MUFAs-0,5xPUFAs

where:

LPS	- lipid preventive score
TL	- total milk fat content (total lipids)
SFAs	- saturated fatty acids
MUFAs	- monounsaturated fatty acids
PUFAs	- polyunsaturated fatty acids

The milk density was examined with a lactodensitometer, BDS 1111-73, and the titratable acidity – according to the Thörner method, BDS 111-80.

White brine cheese was prepared from the milk obtained from both breeds (Tetevenska and Kotlenska). At the end of the milking period, samples of sheep's milk and cheese were obtained from sheep of the Tetevenska and Kotlenska breeds, raised on pastures in the respective regions. The samples were examined to determine the physico-chemical composition. The milk samples were processed on a Milko-Skan device, and the cheese was analyzed with a "Food Skan TM wab 9-2000" device. The acidity of the milk samples and the cheese samples at the 24th hour and the 45th day were determined by the Thörner method. Calcium content was also reported by titration. The cheese is produced from sheep's milk obtained from flocks of 150 sheep of both breeds (Tetevenska and Kotlenska). The milk is processed according to shepherd technology. It is filtered through a strainer several times to remove impurities. It is not pasteurized, but heated to 33-34oC. The yeast is added, diluted with 20ml of water. The milk is stirred well and left for about 1 - 1.30 hours to curdle. It is cut into pieces and transfer to a dish with cheesecloth. The cheesecloth is attached and the curd is drained for 2 hours to separate the whey. After that it is cut into lumps, arranged tightly in the containers in which it will be stored, salted with sea salt for 24 hours to increase the acidity. If the whey is not enough then brine 8-10% salt is added to cover it. It is left for 45 days at a temperature of around 10-12 degrees to ripen.

To establish the reproductive capabilities of the two breeds of sheep, the biological and economic fertility of ewes at 2.5, 3.5 and 4.5 years of age (first, second and third lambing) in 2019, 2020 and 2021 were calculated. Economic fertility was calculated in the percentage of liveborn lambs, compares to the available ewes, and biological in the percentage of live-born + stillborn and aborted lambs to the number of ewes lambed during the year. The data were provided by the breeding organizations: Organization for Breeding of Tsigai, Romanov and Local Sheep Breeds Association in Troyan and Association for Breeding Kotlenska Sheep Breed in Kotel.

The average wool shear was determined, and each fleece was measured with an electronic scale to the nearest 0.05kg. The fleece pigmentation type of Tetevenska and Kotlenska breed of sheep was determined. 50 wool samples from Tetevenska and 50 samples from Kotlenska breed were examined. The natural wool length was measured during bonitizing with a line accurate to 0.5cm. The true wool length was measured to the nearest 0.01cm with a semi-automatic 4-10-1-2 type true fiber length meter.

A study was conducted on the dermatoglyph characteristics of both sheep breeds. The research was conducted in 2018 on 40 ewes at the age of 3 and 4, 20 animals of each breed (Kotlenska and Tetevenska). The age of the animals is taken from the herd books maintained by the breed associations. The photos of the dermatoglyph on the nasolabial plate were taken with a Canon-IXT-18 digital camera at a distance of 25-45cm from the object (nasolabial plate).

A dactyloscopic, blue ink and smudge roller was used to establish its size (area).Prints were made on paper, which then was cut so that the different sections were joined to form a rectangle. The area was determined by the formula - $S = a \times b$ (mm^2).

Dermatoglyphics were visually studied according to the methodology of Trofimenko, (1991), in which the distribution of skin folds, shafts, granules and furrows on the relief surface of the nasolabial plate is analyzed according to the deductive method of photo analysis. The colour of the nasolabial plate was studied, its shades were determined, anatomical, morphometric, morphological morphometric and photographic methods were used to register the established differences.

A monitoring was conducted in the farms with Tetevenska and Kotlenska breeds, and the information was provided by the breeding organizations, such as Organization for Breeding of Tsigai, Romanov and Local Sheep Breeds Association in Troyan and Association for Breeding Kotlenska Sheep Breed in Kotel.

The following methodical approach was used to establish the production and economic results:

- The total production in kind is determined by the actually received stock quantities of milk, meat and wool.
- The total production in terms of value has been established by multiplying the in-kind production (milk, meat and wool) for the year by the current market prices for 2021:
- Material costs are also based on the market prices of concentrated feed, hay, green (juicy) fodder and other material costs.

On the basis of the actual income and expenses for a one-year period, an economic evaluation of the traits of economic significance for both studied sheep breeds was conducted.

Statistical processing was performed with the software product Microsoft Excel. The data were processed according to the methods of variation statistics, the reliability of the influence of the factors was determined by the values of Fisher's F-test, and the significance of differences between the studied groups - by the Student's t-test, with the statistical package Data Analysis, Microsoft Excel 2016.

IV. RESULTS AND DISCUSSION

Task 1. To establish the manifestation and dynamics of the live weight trait in animals of different ages from Tetevenska and Kotlenska breeds.

The selection in terms of live weight is aimed at reaching an optimal level, ensuring maximum manifestation of the other productive signs. Maintaining an excessively high live weight is associated with higher costs, which is economically unjustified.

Table 1. Average live weight in kg of Tetevenska and Kotlenska sheep breeds at different age.

Breeds / **Age**	**Tetevenska**			**Kotlenska**		
	n	**x±Sx**	**C**	**n**	**x±Sx**	**C**
At parturition	40	3,43±0,26	4,74	40	3,01±0,04	8,37
3-month-old	40	21,58±0,27	7,93	40	21,17±0,27	8,14
6-month-old	40	27,92±0,22	4,96	40	27,71±0,15	3,41
9-month-old	40	35,15±0,23***	4,18	40	33,68±0,31***	5,73
12-month-old	38	38,91±0,18	2,99	40	37,53±0,16	2,69

18-month-old	37	42,11±0,27	3,93	39	40,75±0,23	3,47
2.5-year-old	36	43,15±0,26	3,62	37	41,52±0,23	3,41
3.5-year-old	36	43,40±0,28	3,92	37	42,29±0,25	3,57
4.5-year-old	35	43,52±0,28	3,78	36	42,35±0,24	3,40

***** - p<0,001**

The average live birth weight of lambs is about 3.00 kg (Table 1). The average percentage of offspring born for Tetevenska is 12.24%, as they are heavier than Kotlenska sheep breed (p>0.05). The values of the variation coefficients for both breeds are low – 4.74 for Tetevenska breed and 8.37 for Kotlenska breed.

For 3-month-old animals, the difference in live weight is again in favor of Tetevenska breed with 21.58kg, Kotlenska breed with 21.17kg. (p>0.05). From the data on live birth weight and live weight at weaning (3-month-old), it can be concluded that their development is progressing well and corresponds to the specifics of the studied breeds.

The difference in the average live weight of the 6-month-old Tetevenska and Kotlenska animals decreases, but again Tetevenska animals are ahead of Kotlenska animals, albeit by 0.75%.

The female weaned lambs of Tetevenska breed at 9 months of age reliably outperform Kotlenska ones by 4.18%.

One-year-old animals of both breeds reach about 90% of the live weight of the ewes at first lambing - 38.91kg (90.2%) for Tetevenska and 37.53kg (90.4%) for Kotlenska, which is indicative of the good development at a young age and reaching a weight allowing their use for breeding.

The values for the average live weight were higher in Tetevenska breed compared to Kotlenska breed, and the differences for the 9-month-old animals were highly reliable. The other ages lack credibility.

The variation of live weight in all the indicated ages is within relatively narrow limits. For Tetevenska group, the variability of the trait was the lowest in 12-month-old animals - 2.99 and the highest in 3-month-old animals - 7.93. In the Kotlen breed group, the variation is the lowest - 2.69 in animals at 12 months of age and the highest in newborns - 8.37.

The results obtained for the average live weight of animals of the Teteven breed by age are higher than those indicated by Genkovski, (2002) - average live weight at birth - 3.33kg, 35.04kg at 9 months, at 18 months - 41.98kg. In our opinion, this is due to better nutrition and husbandry.

The established average live weight of Kotlenska ewes is significantly higher than that reported by Savov, (1964) – 31.25kg, also than that reported by Zhelev, (2006) – 31-32kg for the ewes, but it is within the range reported by Yordanov et al., (2017) – 35kg-45kg.

Task 2. Exterior measurements and exterior indices in Tetevenska and Kotlenska sheep breeds.

As with other farm animals, there is a close relationship between external forms and productivity in sheep. In sheep there are great differences in exterior. This is closely related mainly to the productive direction and the area of cultivation. By the appearance, and by the

development of the body parts, it is possible to determine what the main production of the sheep is - wool, meat, milk, etc. Based on the exterior, the presence of various bodily defects is judged. Animals with severe defects give low and poor quality production.

Table2. External measurements of mature ewes n=44

Breed / Indicators	Tetevenska		Kotlenska	
	x±Sx	C	x±Sx	C
Withers height	61,44±0,42**	4,55	59,44±0,47**	5,2
Height at the back	60,69±0,40***	4,41	58,34±0,42***	4,8
Sacrum height	62,06±0,34	3,67	59,20±0,45	5,09
Body length	67,42±0,48	4,67	62,98±0,0,49	5,13
Chest girth	80,55±0,47	3,86	80,55±0,63	5,17
Chest depth	26,19±0,22	5,51	25,38±0,36	9,41
Chest width	17,48±0,18	6,64	16,90±0,31	12,2
Cannon bone girth	7,69±0,06	5,1	7,84±0,08	6,84
Head length	20,98±0,12	3,91	20,83 ±0,23	7,23
Head width	11,39±0,09*	5,43	10,94±0,14*	8,43

***- p<0,05, **- p<0,01, ***- p<0,001**

Knowledge of the exterior is necessary in determining the breed and constitutional type of the sheep.

In local sheep breeds, exterior measurements are an important indicator embedded in our and foreign breeding programs for preserving genetic resources (Nedelchev et al., 1995). Depending on the purpose of the study, the exterior measurements may be different in number.

Table 2 shows the exterior measurements of Tetevenska and Kotlenska ewes at 3.5 and 4.5 years of age. The average value of the withers height of Tetevenska ewes is 61.44 cm, which is reliably higher than Kotlenska with 59.44 cm (by 2.00 cm). Similar ratios are also observed in the measurements: height at the back – 60.69cm ($p<0.001$) and 58.34cm; sacrum height, respectively – 62.06cm to 59.20cm. According to the body length indicator, Tetevenska ewes significantly outperform Kotlenska ewes by 4.44 cm, while no difference was found in the chest girth indicator. According to the parameters, such as chest depth, chest width, cannon bone girth, head length and head width, insignificant differences in favor of Tetevenska sheep were also found. The variation in the different measurements in Tetevenska sheep is low, as it was the lowest is for the height of the sacrum - 3.67%, and the highest - 6.64% for the chest width. In Kotlenska sheep, the variation in individual traits is low, with the lowest being 4.8% for back height, and the highest for chest width – 12.20%. The low variation in both study groups is a sign of good evenness of animals within the groups.

The results we found for the exterior measurements for Tetevenska breed are lower than those of Genkovski, (2002) for withers height - 63.15cm, body length - 68.80cm, chest width

- 19.95cm, chest depth – 28.70cm, chest girth – 97.30cm, cannon bone girth – 8.54cm. For Kotlenska breed, the results obtained in our measurements of the exterior are higher than those published by (Savov, 1964) - withers height - 57.4cm, body length 60.2cm, chest depth - 27.0cm, chest width – 16.2cm and cannon bone girth – 6.6cm. The observed differences are probably the result of better feeding and the in situ selection applied in the studied herds.

The exterior indices established during our study of ewes from Tetevenska and Kotlenska breeds are reflected in Table 3.

Table3. Exterior indeces ***n=44***

Breeds **Indeces**	**Tetevenska**	**Kotlenska**
Leg length / height index	57,31	57,24
Extension index	109,91	106,13
Chest index	66,81	67,24
Compactness index	119,64	128,12
Body superstructure index	101,06	99,65
Bone growth index	12,55	13,22
Head size index	34,21	35,12
Massiveness index	131,29	135,73

From the data, it is clear that Tetevenska ewes outperform those from Kotlenska in leg height index by 2.06%, extension index by 3.78%, body superstructure index by 1.41%. The results of Kotlenska sheep are higher than those of Tetevenska sheep in terms of the chest index by 0.43%, the compactness index is significantly in their favor - 8.4%, the Bone growth index by 0.67%, the index for head size by 0.91% and massiveness index by 4.44%.

Based on the values of the indices, it can be assumed that the ewes of Kotlenska breed are smaller, with a more compact body and a stronger bone system, while the Tetevenska are taller and with a longer body, which leads to the conclusion that it approaches the dairy type of sheep.

The data obtained from the external measurements and indices are a basis for updating the standards of the two breeds of sheep. They are important criteria that must be periodically taken into account in order to establish the presence or absence of dynamics in their exterior and the effect of carrying out supportive selection.

Task 3. To conduct morphological characteristics of animals.

To identify the dermatoglyph in Tetevenska and Kotlenska sheep breed.

The skin surface colour of the nasolabial plate of Tetevenska sheep shows different combinations - black with different shades, from light black to anthracite, shiny black-45%, gray-35%, cream, white, gray-brown, gray-pink-white, gray-brown-20%. Unpigmented areas on the surface of the nasolabial plate were also observed in 11.7% of the examined sheep. In all animals, a halo of black, white, gray or brown cover hairs forms around the nasolabial plate.



a b c

Fig 1 Dermatoglyph types in Tetevenska sheep breed

a- "Granular" dermatoglyph type b- "Furrow" dermatoglyph type c- "Cross" dermatoglyph type

The shape of the nasolabial plate is drawn peaked, resembling an irregulara triangle whose arrangement is symmetrical. Elongated, slit-shaped and oval nostrils are found. The epidermal layer of the skin of the nasolabial plate has a wrinkled surface. The folds are average-sized, have a roll-like shape and form skin ridges.

The visual assessment of the sample classified three types of dermatoglyph:

"Granular" dermatotype - no dividing furrows are observed. It is characterized by a uniform surface of the nasolabial plate. The structure type is solid. It occurs in 47.5% of the examined sheep. (Fig. 6a)

“Furrow” dermatotype - in this dermatotype, the nasolabial plate is divided into two halves by a deep central furrow, measuring from 5.5mm to 7.5mm. From this central furrow, other furrows emerge forming folds with a depth of 0.03mm -0.05mm. The shape of these furrows is different – straight, curved, wavy, arched. In the dorsal part of the nasolabial plate, the shape of the skin folds is irregular polygons. In the central part, this shape is oval, and in the ventral part, the shape is elliptical. The structure of the dermatoglyph is loose in the central part, and dense in the peripheral part. It occurs in 40% of the examined sheep. (Fig. 6b)

"Cross" dermatotype - in it, the nasolabial plate is divided into two parts by a central furrow and into two more parts by a deep furrow starting from the end of the right nostril and ending at the end of the left nostril. Furrows are usually straight, wavy or arcuate. The shape of the skin folds in the dorsal part is 5-6-7 wall polygons, in the central hour 4-5 wall irregular polygons and in the ventral part oval fragments. The structure of the dermatoglyph is loose. It occurs in 12.5% of the examined sheep. (Fig. 6c)

Table 4 presents the data on the morphometric indicators of the nasolabial plate in Tetevenska and Kotlenska breeds.

Table 4. Morphometric indicators of the nasolabial plate in Tetevenska and Kotlenska sheep (x±Sx) ***n=20***

Breed and age of sheeps	**Area of the nasolabial plate, mm²**	**Amount of skin folds (rolls) number**	**Length of furrows, mm**		
			Dorsal part, mm	**Central part, mm**	**Ventral part, mm**

	x±Sx	x±Sx	x±Sx	x±Sx	x±Sx
Tetevenska 3/4-year-old	40,24±0,31*	115,39±0,48	2,3±0,12	2,6±0,12	2,9±0,14
Kotlenska 3/4-year-old	41,28±0,41*	118,34±0,33	2,4±0,14	2,7±0,12	3,1±0,13

***- p<0,05**

The examined area of the nasolabial plate in the Tetevenska sheep breed is 40.24mm². There are 115.39 skin folds. The length of the skin folds (rolls) has the highest values in the ventral part of the nasolabial plate - 2.9mm.

The nasolabial plate of a large part of Kotlenska sheep is characterized by a black, anthracite-saturated color - 80%, in 17.5% the color is gray and light gray, and 2.5% of the sheep have a patterned tricolor, pink-brown-white color of nasolabial plate. Non-pigmented areas of the nasolabial plate were also observed in 9.75% of the animals examined. The nasolabial plate is bounded from the muzzle by a ring of lighter white, gray or brown coverts.



a b c

Fig 2 Dermatoglyph types of Kotlenska sheep

The shape of the nasolabial plate is spear-shaped, heart-shaped resembling a triangle. The observed shape of the nostrils is different: pear-shaped, oval, slit-shaped. The classification of Kotlenska sheep visually shows three types of dermatoglyph (Figure 7): a- "Granular", b- "Furrow", c - "Cross"

There are no dividing furrows in "Granular" dermatotype. The surface of the nasolabial plate is uniform. The structure is dense It occurs in 25% of the examined sheep.

In "Furrow", the nasolabial plate is divided into two parts by a deep, well-defined central furrow with a depth of 6mm-8mm in places. Furrows of different shapes are associated with it, limiting the skin fragments with a depth of 0.5 mm to 1 mm Furrows can be arcuate, straight and curved. The shape of the skin folds (rolls) is of irregular 5-7 wall polygons in the dorsal part, in the central part the folds are oval, and in the ventral part of the nasolabial plate, their shape is ellipses or they are almost round. The structure of the dermatotype is loose in the central part and dense in the peripheral parts. It occurs in 52.5% of the examined sheep.

The nasolabial plate in "Cross" dermatotype is divided into two parts by a central deep furrow and into two more parts by another deep furrow starting from one nostril and ending at the other nostril. In the isolated parts, wavy and straight furrows are found. The shape of the skin folds (rolls) in the dorsal and central part is of irregular 4-6 wall polygons, and in the

ventral part the shape is oval or round. The structure of the dermatotype is loose. It occurs in 22.5% of the examined sheep.

The area of the nasolabial plate in the studied Kotlenska sheep is 41.28mm². The number of skin folds (rolls) forming phenocomplexes is 118.34. The length of the skin folds (rolls) has the highest values in the ventral part of the nasolabial plate - 3.1mm.

Our results correspond and are close in value to the results obtained by Malofeev and Lipovik, (2011), Lipovik, (2013) and Markova, (2016,2017) in the study of the dermatotypes of the Altai sheep breed, the Black-headed Pleven, Srednostaroplaninska and Koprivshtitsa autochthons sheep breed.

Task 4. To Study of fertility in Tetevenska and Kotlenska ewes.

Data on biological and economic fertility for the Tetevenska and Kotlenska breeds by year are shown in Table 6.

Table 5. Economic and biological fertility (%) by year for Tetevenska and Kotlenska sheep breeds.

Breeds / Years	Tetevenska		Kotlenska	
	Economic fertility %	**Biological fertility %**	**Economic fertility %**	**Biological fertility %**
2019	94.36	128.35	90.3	102.0
2020	97.53	103.85	96.2	102.2
2021	98.52	101.03	94.58	103.0
Average	96.80	111.07	93.33	102.4

The economic fertility for the investigated three-year period in both breeds is below 100%. It was established that in Tetevenska it varied from 94.36% in 2019 to 98.52% in 2021, and in Kotlenska it was 90.3% in 2019 and 96.2% in 2020, respectively. This difference is observed not only in individual years, but also throughout the entire period under study. In terms of economic fertility, sheep from Tetevenska breed are superior to sheep from Kotlenska breed. It is possible that this is due to both breed affiliation and a difference in feeding and rearing conditions during the random and lambing campaigns.

The biological fertility of sheep in both breeds has relatively high values. For Tetevenska sheep breed in 2021, it was the lowest -101.03%, and in 2019 - the highest - 128.35%. In Kotlenska sheep, the variation is significantly lower compared to Tetevenska sheep, but they have the highest percentage of biological fertility in 2021 with 103.0%. 103,0%. The average biological fertility for the studied years in the Tetevenska breed is higher than that of the Kotlenska by approximately 9%, but it is within the breed

Table 6 shows the results for the biological and economic fertility of the two studied breeds depending on the age of the sheep.

Table 6. Economic and biological fertility by age for Tetevenska and Kotlenska sheep breeds.

Breeds	2.5 years			3.5 years			4.5 years		
	n	**Biological fer-**	**Economic fertil-**	**n**	**Biological fertility**	**Economic fertil-**	**n**	**Biological fertil-**	**Economic fertility**

		tility		ity					ity			ity			
		x ± Sx	C	x ± Sx	C		x ± Sx	C	x ± Sx	C		x ± Sx	C	x ± Sx	C
ТТВ	173	109,9 ±1,66	2,64	100,6 ±0,71	1,23	154	121,49 ±3,66	5,22	101,22 ±0,71	2,29	134	115,38 ±3,43	5,15	101,53 ±0,98	1,67
КОТ	144	107,83 ±3,58	5,75	99,03 ±5,75	10,06	121	106.0 ±1.825	14,72	100,75 ±0,77	1,33	118	110,90 ±0,91	1,42	100,41 ±0,42	0,72

The biological fertility of Tetevenska sheep at the first lamb is 109.9%, at the second - 121.49% and at the third 115.38%, and Kotlenska sheep respectively - at the first - 107.83%, at the second - 111.18% and at the third 110.90%. The highest biological fertility in Tetevenska breed is at the second lambing (3.5 years old) - 121.49%, followed by that at the third lambing 115.38% and the lowest at the first lambing 109.9%. In the case of Kotlenska breed, in general, the percentage of biological fertility is inferior to that found in Tetevenska breed, as it is the highest also at the second lambing - 111.18%, followed by that obtained at the third lambing - 110.90% and the most low at first lambing - 107.83%.

The economic fertility is also relatively high in both breeds. In the case of Tetevenska sheep, it is slightly over 100% at all three ages, the lowest being at the first lambing – 100.6%, and at the third and second it is almost equal, respectively 101.53% at the third and 101.22% at the second lamb. The results of Kotlenska breed are slightly lower than those of Tetevenska. The lowest economic fertility is found in the first lamb of Kotlenska breed with 99.03%, as in the second and third one it is almost the same and is over 100%.

Task 5. To assess the meat productivity in Tetevenska and Kotlenska sheep breeds.

Growth rate and feed consumption per unit of lamb production are the factors determining the economic efficiency of sheep farming in the foot-hill and mountains of Bulgaria, and for herds raised without milking, it is crucial.

The data for accumulation of live weight for a 60-day fattening period of lambs from the studied breeds in the region of the Central Balkan Mountain are showed in Table 7.

Table 7. Average live weight at the beginning and end of the experiment and average daily gain for a 60-day fattening period in kg

Breed	n	Sex	Live weight at the beginning of the experiment x±Sx	Live weight at the end of the experiment x±Sx	Absolute growth kg	Average daily gain, kg
Tetevenska	4	M	16,45±0,61*	31,25±1,13	14,80±1,14	0,25±0,02
	4	F	16,95±1,05	29,00±0,14	12,05±0,93	0,20±0,02
Kotlenska	4	M	20,75±1,11*	32,75±0,63	12,00±0,58	0,20±0,01
	4	F	20,00±1,22	30,00±1,94	10,00±1,13	0,17±0,02

***- p<0,05**

The male Tetevenska lambs had the highest live weight at the beginning of the experiment with 20.75 kg, whereas the male Tetevenska lambs had the lowest with 16.45 kg, as there is credibility of the differences in terms of their average live weights Male lambs of Tetevenska breed had the highest growth rate compared to those of the other 3 experimental

groups. The average daily gain for the entire fattening period for them is 0.250 kg, which represents 20%. Growth rate of Tetevenska female lambs was also higher by an average of 0.034 kg (by 15%) compared to the analogous group of Kotlenska breed. When the experiment was set, the lowest average live weight (16.45 kg) were registered for 'Tetevenska' male lambs, but in the fattening process they went ahead of the female animals. They have the highest average daily growth. For Kotlenska animals, a higher growth rate was also observed in males compared to females by 15%.

Table 8. Feed consumption in FUG andPDI per 1kg of growth

Breed	n	Sex	Feed consumption per 1kg of growth		Fodder units for growth /FUG/	Protein digestible in intestine /PDI/
			Concentrated fodder, kg	Bulk feed kg		
Tetevenska	4	M	2,02	3,56	3,93	611
	4	F	2,48	4,37	4,83	751
Kotlenska	4	M	2,49	4,32	4,81	748
	4	F	2,99	5,18	5,77	897

The feed consumption in FUG and PDI per 1 kg of growth was the lowest in male 'Tetevenska' lambs (3.93 KEP and 611 g PDI), and the highest in female Kotlenska lambs (5.77 FUG and 897 g PDI). Male Tetevenska lambs spent 18.63% less FUG and 18.64% less PDI per 1 kg of growth than females of the same breed. Male Tetevenska lambs spent 16.6% less FUG and 18.61% less PDI per 1 kg of growth than females of the same breed.

The data analysis shows that the male Tetevenska breed achieve 1 kg growth with 18.30% less FUG and 18.32% less PDI compared to those of Kotlenska breed. Female lambs of Tetevenska breed spent 16.29% less FUG and 16.28% less PDI per 1 kg of growth than females of 'Kotlenska' breed.

The obtained results are lower than those reported by Markova et al., (2018) in fattening lambs from the Srednostaroplaninska and Koprivshtitsa breeds. In order to reach a pre-slaughter live weight close to that of Tetevenska and Kotlenska lambs, 5.46-6.30 FUG and 838-982g PDI were spent in Srednostaroplaninska lambs and 5.71-5.88 FUG and 890-916g PDI were spent in the fattening of Koprivshtitsa lambs.

The established mean values of live weight before slaughter, hot carcass weight, cold carcass weight and slaughter yield by breed and sex are shown in Table 9.

Table 9. Pre-slaughter live weight, hot carcass weight and slaughter yield

Breed		Tetevenska		Kotlenska	
n		3♂	3♀	3♂	3♀
Pre-slaughter live weight kg	x±Sx	30.67±1.36	27.83±0.17	33.33±0.33	30.17±2.24
	C	7.71	1.04	1.73	12.87
Hot carcass weight kg	x±Sx	11.57±0.79	11.73±0.15	13.63±0.38	12.17±1.01
	C	11.80	2.14	4.88	14.43
	x±Sx	11.28±0.75	11.24±0.11	13.19±0.43	11.83±0.92

Cold carcass	**C**	11.50	1.71	5.70	13.54
Slaughter yield weight kg %		37,72	42,16	40,90	40,33

p>0,05

The female Tetevenska lambs have the highest percentage after 24 hours of carcass cooling compared to the pre-slaughter weight - 40.38%, as the lowest percentage was found in the males of the same breed - 36.77%. In male and female animals of Kotlenska breed, the difference between the ratio of the values of the cooled carcass and their pre-slaughter weight is closer, respectively 39.57% for males and 39.23% for females, and they are slightly lower than those of Tetevenska females, as they yield only with 1%.

The economic interest in meat production of young categories of animals is determined by live weight. It is a criterion for quantitative accumulation of meat, without paying attention to its edible part. Meatiness or the so-called meatiness coefficient is the ratio of meat, subcutaneous and intermuscular fat of the carcass to live weight The criterion for fatness of the carcasses in different countries, nations and ethnic groups of people is different. In Arab countries, preferences are for a higher percentage of fat in meat. In recent years, preferences for meat with a reduced content of subcutaneous and intermuscular fat have been established for a healthy diet. In Germany, the optimal subcutaneous fat thickness imposed by lamb consumers is 2 – 3 mm (Schlalont, 1983).

Table 10 shows the slaughter indicators for seperate parts of the carcass and internal organs in kg and percentage of live weight before slaughter by breed.

Table 10. Average values of slaughter indicators and average % of live weight

Slaughter traits			**Breed**							
			Tetevenska				**Kotlenska**			
			m		f		m		f	
Measuring units			kg	%	kg	%	kg	%	kg	%
			x±Sx		x±Sx		x±Sx		x±Sx	
Live weight before slaughter			30,67±1,364		27,83±0,167		33,33±0,333		30,17±2,242	
Carcass - kg	**Hot**		11,57±0,788	37,72	11,73±0,145	42,16	13,63±0,384	40,9	12,17±1,014	40,33
	After 24-hour-cooling	**Whole**	11,28±0,750	36,77	11,24±0,111	40,38	13,19±0,434	39,57	11,83±0,925	39,23
		Left half	5,70±0,260	18,59	5,86±0,020	21,05	6,69±0,190	20,06	5,90±0,532	19,55
Head		**Skinned**	1,12±0,034	3,65	1,02±0,023	3,66	1,23±0,040	3,69	1,09±0,085	3,61
		Skin	0,57±0,029	1,85	0,44±0,006	1,59	0,77±0,109	2,31	0,47±0,043	1,55
Legs			0,75±0,032	2,43	0,67±0,010	2,4	0,72±0,024	2,17	0,66±0,063	2,19
Skin Carcass			3,95±0,030	12,88	3,74±0,283	13,42	5,08±0,436	15,23	4,08±0,394	13,52
Empty bowels		**Small intes-tine**	0,78±0,012	2,54	0,67±0,029	2,4	0,73±0,023	2,19	0,68±0,108	2,25
		Colon	0,62±0,038	2,02	0,72±0,039	2,57	0,58±0,048	1,74	0,71±0,101	2,35
		Liver	0,77±0,100	2,51	0,59±0,044	2,11	0,70±0,007	2,1	0,57±0,047	1,88

	Lungs	0,55±0,040	1,79	0,47±0,016	1,7	0,59±0,014	1,78	0,58±0,053	1,91
Heart		0,15±0,014	0,49	0,12±0,019	0,44	0,18±0,019	0,55	0,14±0,017	0,46
Spleen		0,12±0,021	0,39	0,05±0,007	0,19	0,16±0,008	0,49	0,13±0,016	0,42
Rumen		1,00±0,099	3,26	0,90±0,044	3,24	0,95±0,025	2,84	0,94±0,113	3,12
Internal fat around the intestines, stomach, kidneys, pelvic cavity		0,19±0,020	0,6	0,35±0,013	1,26	0,35±0,029	1,06	0,44±0,034	1,46
Kidneys		0,1±0,007	0,33	0,11±0,008	0,4	0,13±0,006	0,38	0,10±0,005	0,33
Tail		0,08±0,004	0,27	0,09±0,001	0,32	0,09±0,003	0,26	0,10±0,009	0,31
Testicles		0,13±0,035	0,42	-	-	0,29±0,032	0,88	-	-

p>0,05

Female Tetevenska lambs have the highest percentage of carcass weight after 24-hour cooling, compared to pre-slaughter weight - 40.38%, as male lambs from the same breed have the lowest - 36.77%. In male and female Kotlenska lambs results are very close, respectively - 39.57% and 39.23%, (p>0.05).

Table 11. Weight of the seperate parts in the cut and % weight of the half.

Parts in the cut	**Breed**							
	Tetevenska				**Kotlenska**			
	m		f		m		f	
	kg	**%**	**kg**	**%**	**kg**	**%**	**kg**	**%**
	x±Sx		**x±Sx**		**x±Sx**		**x±Sx**	
neck	0,484±0,011	8,45	0,484±0,064	8,33	0,538±0,117	8,27	0,397±0,070	6,81
Shoulder	1,095±0,050	19,11	1,048±0,013	18,04	1,074±0,198	16,5	1,127±0,093	19,35
Loins	0,601±0,017	10,5	0,724±0,029	12,47	0,707±0,064	10,87	0,574±0,058	9,85
Leg	1,877±0,120	32,75	1,805±0,036	31,08	2,075±0,099	31,89	1,859±0,103	31,91
Chest	1,220±0,072	21,3	1,311±0,054	22,57	1,534±0,089	23,57	1,341±0,145	23,01
Abdomen	0,370±0,034	6,46	0,346±0,005	5,96	0,493±0,034	7,58	0,434±0,071	7,44
Tail	0,082±0,004	1,44	0,090±0,001	1,54	0,086±0,000 3	1,33	0,095±0,009	1,63

p>0,05

The obtained values from the cut of the left half show that the leg has the highest weight and the largest relative share in all studied groups (Table 11). The highest leg weight was found in male Kotlenska lambs with 2.075 kg, which represents 31.89% of the left half. In Tetevenska male animals, the leg occupy 32.92% of the weight of the left half (1.877kg), followed by Kotlenska female animals (1.859kg), which is 31.91%. Female Tetevenska lambs have the lowest weight and relative share of leg of 1.805kg and 31.08%.

Second place in terms of relative share of the left half in all groups is occupied by the weight of the chest. The lowest weight according to this indicator - 1,220 kg and the lowest

relative share of the weight of the left half - 21.30% are the male Tetevenska lambs. In male Kotlenska lambs, the weight is 1,534 kg and the relative share is the highest - 23.57%. The differences in this indicator in female animals are minimal, as the weight of the chest in Tetevenska females is 1.311kg and a relative share - 22.57%, and in Kotlenska females the values are respectively - 1.341kg and 23.01% (p>0, 05).

The indicators for the meat from the shoulder are in the third place, as the differences between the groups are relatively small. The highest shoulder weight is observed in female Kotlenska lambs - 1.127kg and the highest relative share of the weight of the left half - 19.35%. Male Kotlenska lambs have the lowest relative share – 16.5%. The values of this indicator for Tetevenska lambs are close.

In all other sections, the relative shares of the weight of the halves, the results are close in average values and do not give grounds for indicating breed and sex differentiation (p>0,05).

The results of the research on the physico-chemical parameters of the meat from m. Semimembranosus and m. Longissimus by breeds are reflected in Table 12.

Table 12. Physico-chemical composition of m. Semimembranosus and on m. Longissimus …n=6

Indicators %	Semimembranosus				Longissimus			
	Tetevenska		**Kotlenska**		**Tetevenska**		**Kotlenska**	
	x±Sx	C	x±Sx	C	x±Sx	C	x±Sx	C
Water	71,29±1,08	3,71	71,26±1,5	3,95	68,22±2,71	9,72	73,10±0,68	2,27
Protein	18,35±0,11	1,44	18,32±0,08	1,08	18,51±0,51	6,77	19,64±0,19	2,33
Fats	10,00±0,26	26,2	9,71±1,13	28,4	12,81±3,43	65,52	5,97±0,87	35,52
Collagen	1,76±0,08	11,14	1,94±0,10	12,15	2,27±,024	25,34	2,22±0,14	15,1
Tenderness	149,30±3,14*	10,08	134,63±2,44*	4,44	144,85±7,43	12,56	130,78±2,69	5,04
Water Holding Capacity	29,93±1,92	15,72	32,78±0,72	5,38	32,64±0,87	6,51	33,42±1,09	8,01
pH	5,63±0,03	1,51	5,67±0,02	0,71	5,56±0,09	3,91	5,66±0,02	0,94

***p<0,05**

One of the important characteristics determining the quality of the meat is the ability of the muscles to retain chemically unbound water (Water Holding Capacity). It has a direct relationship with taste, fragility, color, etc. The differences are small and mathematically unproven. The difference is also less significant for the established amounts of proteins. The relative share of fat in the meat of Tetevenska lambs is higher compared to that found in Kotlenska lambs, as in m. *Longissimus* from the Tetevenska animals significantly exceeds with 12.81 the other groups.

Table 13. Chemical composition of m. Semimembranosus and on m. Longissimus n=3

Indicators %	Semimembranosus				Longissimus			
	Tetevenska		**Kotlenska**		**Tetevenska**		**Kotlenska**	
	x±Sx	**C**	**x±Sx**	**C**	**x±Sx**	**C**	**x±Sx**	**C**
Ca %	0,010±0,0002	4,61	0,0102±0,0003	6,437	0,010±0,0002	4,66	0,010±0,0002	5,84

P %	0,1998±0,0031	3,79	0,1943±0,0028	3,53	0,196±0,0033	4,12	0,190±0,0036	4,69
K mg/100g	275,0612±2,8856	2,57	264,6912±4,9817	4,61	269,065±3,3634	3,06	264,668±6,1408	5,68
Mg mg/100g	25,2707±0,6984	6,77	24,753±0,320	3,16	24,717±0,3783	3,75	24,626±0,3510	3,49
Zn mg/100g	2,167±0,0736	8,32	3,1538±0,0806	6,26	2,022±0,0299**	3,62	2,763±0,1162**	10,3
Mn mg/ 100g	0,0195±0,0009**	11,74	0,0163±0,0002**	2,41	0,019±0,0008*	9,78	0,016±0,0003*	4,24
Cu mg/100g	0,2022±0,0145	17,53	0,194±0,0212	26,81	0,204±0,0139	16,74	0,180±0,0192	26,26
Fe mg/100g	1,433±0,0686	11,72	1,5133±0,0602	9,74	1,430±0,0489	8,37	1,540±0,0401	6,38

***- p<0,05, **- p<0,01**

The results of the examined meat samples of m.Semimembranosus taken from fattened lambs of both breeds did not show significant differences (Table 13). The content of macro- and microelements in the meat of m. Longissimus of Tetevenska lambs is higher than that of Kotlenska lambs except for zinc and iron. Credibility of the differences was established only regarding the content of Zn, Mn and Fe. The differences in the remaining elements are small and insignificant (p>0.05).

In the meat samples in m. Semimembranosus the content of macro- and microelements, also no significant differences were found. Their quantities are of a similar content to those found at m. *Longissimus.* The content of Mn and Fe was again greater in Kotlenska lambs, but differences were only demonstrated for Mn.

In the meat of Kotlenska lambs, a higher content of the elements P and Cu in m was recorded in m. *Semimembranosus,* compared to Tetevenska lambs. Our results correspond with those reported by Slavov, (1990) for lambs of Planinski Corriedale, Tsigai and the crossings between them and are lower than those reported by Markova, (2019) for Srednostaroplaninska and Koprivshtitsa breeds

Lamb meat is rich in micro and macro elements, which defines it as a meat with good taste and health benefits.

Lamb meat is extremely healthy. Pasture feeding has been found to result in a lower content of saturated and a higher proportion of unsaturated fatty acids. Dervishil et al., (2010) confirmed that using two grazing systems for lambs resulted in a higher concentration of vaccenic acid (VA) and CLA and lower oleic (C18:1) and stearic content acid (C18:0), which ensures an increased ratio of Omega-6/Omega-3 fatty acids. Demirel, (2006) reported an increased content of polyunsaturated fatty acids when lambs were fed on dried grass than when fed on a concentrate diet.

The distribution of fatty acids in meat by group is reflected in Table 14 and Table 15.

Table 14. The distribution of fatty acids in m.Longissimus by groups and breeds n=3

Fatty acids	**Tetevenska sheep breed**		**Kotlenska sheep breed**	
	x±Sx	**C**	**x±Sx**	**C**
Σ UFA	47,25±0,69	1,45	48,78±0,67	2,37

Σ MUFAs	48,41±0,78	1,61	46,51±0,87	3,23
Σ PUFAs	4,34±0,22	5,06	4,71±0,21	7,66

p>0,05

Table 15. The distribution of fatty acids in m.Semimembranosus by groups and breeds *n=3*

Fatty acids	**Tetevenska sheep breed**		**Kotlenska sheep breed**	
	x±Sx	**C**	**x±Sx**	**C**
Σ UFA	49,58±0,58	2,04	49,51±1,35	4,73
Σ MUFAs	45,63±0,87	3,30	46,73±1,12	4,15
Σ PUFAs	4,79±0,53	19,06	3,76±0,41	19,04

p>0,05

The amount of unsaturated fatty acids (UFA) in the meat of Tetevencka and Kotlencka lambs is similar. The relatively high level of saturated fatty acids in meat corresponds to lower values of monounsaturated fatty acids. The amount of MUFAs found in m. *Longissimus* fat in Tetevenska lambs is higher. The biologically important PUFAs/SFAs ratio, known as the P/S ratio, in the studied lamb meat is low and varies within narrow limits - 0.10% for m. *Longissimus* and 0.08-0.09% for m.Semimembranosus. Monounsaturated fatty acids have a preventive effect in relation to coronary and cardiovascular diseases, the effect is similar to polyunsaturated fatty acids, but they are more susceptible to oxidation due to their greater unsaturation. PUFAs protect cell membranes from oxygen radicals almost as much as tocopherol and less than carotene (Gerchev et al. 2018).

In the examined meat, short-chain fatty acids were reported in single animals. Whereas medium-chain fatty acids predominated in samples from both breeds. The content of long-chain fatty acids in the meat of both muscles was similar and no significant differences were found between the breeds. The ratio between Ω-6 and Ω-3 in m. *Longissimus* is relatively high - respectively 10.20 in Tetevenska and 7.56 in Kotlenska, whereas in m. *Semimembranosus* this ratio has insignificant differences between the studied breeds, respectively 9.48 in Tetevenska lambs and 9.56 in the Kotlenska lambs. These high values are due to the content of linoleic fatty acid (C18:2) in the examined muscles.

Task 6. To study of milk productivity in Tetevenska and Kotlenska breeds.

To determine milk yield in Tetevenska and Kotlenska ewes.

In the past and currently in Bulgaria, almost all local breeds are used for milk production, including the sheep of Tetevenska and Kotlenska breeds studied by us.

With the advent of market relations in the Republic of Bulgaria, the milk yield of sheep turns out to be one of the important economic indicators. In recent years, the relative share of income from milk and milk products has increased significantly.

The results obtained by us for determining the milk yield of sheep from Tetevenska and Kotlenska breeds for a 90-day milking period are reflected in Table 16.

Table 16. Milk yield by controls, average daily milk yield and milk yield in l.

Breeds	n	Average daily milk yield						Milking milk production	
		I control		II control		III control			
		x±Sx	C	x±Sx	C	x±Sx	C	x±Sx	C
Tetevenska	50	0,598±0,02	30,41	0,618±0,03	34,74	0,568±0,02	34,09	59,960±2,09*	24,64
Kotlenska	50	0,535±0,02	38,17	0,605±0,02	36,81	0,537±0,02	39,41	50,328±2,13*	29,92

p<0,05

The milking milk production of Tetevenska ewes is relatively high - 59,960 l (Table 16) and reliably (p<0.05) exceeds by 16.06% the 50,328 l found in Kotlenska breed. There is also a big difference in the average daily milk yield, 0.666 l in Tetevencка sheep, against 0.559 l in Kotlenska sheep. The variation coefficient in both breeds is relatively high, and in Kotlenska breed it is higher - 29.92%. Our results for the milking milk production of Tetevenska sheep are close in terms of values to those established by Genkovski (2002) for Tetevenska sheep breed is 61.77 l. The obtained milking milk productivity in Kotlenska sheep is close to that reported by Hristova, (1990) – 38-50 l.

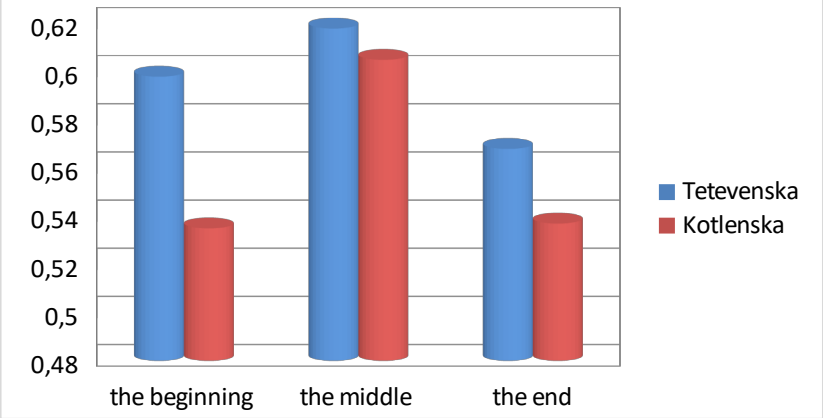


Fig3. Dynamics in milk yield by breed in ml

The milk yield of the sheep increases at the beginning (April) towards the middle (May) of the lactation and towards the end there is a decrease (Figure 3). The milking period coincides with grazing. At the beginning and in the middle of lactation, the grass stand is at its maximum development, and towards the end it is scarcer. The observed decrease is also related to the physiological characteristics of animals to naturally reduce their milk productivity and accumulate reserves in preparation for the reproductive period.

Table 17. Macro- and microelements in sheep's milk from Tetevenska and Kotlenska sheep breed. ***n=6***

Indicators	Breeds

	Tetevenska		**Kotlenska**	
	x±Sx	**C**	**x±Sx**	**C**
Macroelements				
Calcium %	0,205±0,002	2,88	0,204±0,002	2,56
Phosphorus %	0,151±0,004	6,66	0,160±0,002	3,40
Potassium mg/100g	121,214±1,249	2,52	119,193±1,28	2,63
Magnesium mg/100g	18,316 ±0, 192	2,56	17,911±0,223	3,04
Microelements				
Zink mg/100g	0,468±0,003	1,63	0,471±0,002	1,26
Manganese mg/100g	0,012±0,002	4,66	0,012±0,003	6,49
Copper mg/100g	0,036±0,005**	3,56	0,040±0,005**	3,08
Iron mg/kg	0,104±0,004	8,36	0,106±0,002	5,08

****- p<0,01**

From the data presented in Table 17, it is clear that the amount of calcium (Ca) in the milk of Tetevenska and Kotlenska sheep has very close values - 0.205% for Tetevenska sheep and 0.204% for Kotlenska sheep (p>0.05). Markova, (2019) found close to our results in the milk of the Srednostaroplaninska and Koprivshtitsa sheep - 0.203 and 0.209 and Gerchev and Mihaylova, (2012) in the milk of Tetevenska sheep - 0.208.

In terms of phosphorus levels, Kotlenska sheep milk exceeds Tetevenska milk by 5.62%, respectively 0.151 for Tetevenska milk and 0.160 for Kotlenska milk. Lower than data was reported by Markova, (2019) for Srednostaroplaninska breed of sheep - 0.139 and the Koprivshtitsa sheep breed - 0.149.

The milk of Tetevenska sheep has a 1.67% higher content of potassium (K) and a 2.21% higher content of magnesium (Mg) compared to the milk of Kotlenska sheep. The difference in the content of trace elements iron (Fe, mg/kg) and zinc (Zn, mg/kg) in milk is minimal and lacks credibility. The same values were reported for Mn, mg/kg – 0.012 (p>0.05).

The content of macro- and micro elements in milk is largely determined by the feeding

during the milking period, which is mainly pasture grass. It should be noted that, probably, the grass composition of the pastures has a richer content of macro- and microelements. Their presence in milk is in an optimal ratio for absorption by the digestive tract. Milk is a source of calcium, phosphorus, potassium, sodium, etc. minerals necessary for the growth and formation of the bone system.

The fat in milk has a significant influence, in addition to the taste qualities of milk and milk products, but also on its biological and nutritional value. The content of fatty acids in milk fat determines these indicators.

Table 18. Groups of fatty acids in milk *n=6*

Fatty acids	Tetevenska sheep breed		Kotlenska sheep breed	
	x±Sx	C	x±Sx	C
Σ SFAs	68,073±1,612	2,37	67,876±0,561	2,03
Σ MUFAs	26,758±0,666	6,10	26,745±0,485	4,45
Σ PUFAs	5,168±0,135	6,40	5,378±0,164	7,50
Σ C4:0-C11:0	11,04±0,38	8,46	10,88±0,18	3,94
Σ C12:0-C16:1	43,38±0,93	5,26	43,73±0,84	4,68
Σ over C17	45,58±1,13	6,07	45,39±0,72	3,87

p>0,05

The total amount of saturated fatty acids (Table 18) in milk fat has similar values in both breeds. High levels of saturated fatty acids correspond to lower levels of both monounsaturated fatty acids (MUFAs) and significantly lower levels of polyunsaturated fatty acids (PUFAs). Insignificantly higher values of PUFAs and medium-chain fatty acids are reported in the milk of Kotlenska sheep, compared to the same indicators in Tetevenska sheep, but the differences are not reliable.

Tetevenska breed is characterized by higher milk yield and higher milk parameters, such as protein, casein and milk fat, compared to the parameters of Kotlenska breed. The higher content of protein and casein in the milk of Tetevenska breed suggests relatively higher values of essential amino acids. The differences in the composition of the milk obtained from the two breeds are probably due to interbreed differences and uneven conditions of rearing and feeding, as well as the specific climate in the habitats of the Tetevenska and Kotlenska breeds of sheep.

The content of milk fat, including saturated and unsaturated fatty acids in the milk of the studied breeds are close in value. A higher percentage of monounsaturated (MUFAs) and long chain fatty acids was found in the milk of Tetevenska sheep and polyunsaturated (PUFAs) in that of Kotlenska sheep. In terms of polyunsaturated fatty acids, linoleic acid (C18:2) is superior in content to linolenic acid (C18:3).

The fatty acid composition of the studied fats in milk makes it possible to determine

indicators important for healthy nutrition - Atherogenic Index (AI) and Lipid Preventive Score (LPS). The established values of AI and LPS indices of milk from Tetevenska and Kotlenska sheep are indicated in Table 19.

Table 19. Milk indices of Tetevenska and Kotlenska sheep. ***n=6***

Indeces	**Tetevenska**		**Kotlenska**	
	x±Sx	**C**	**x±Sx**	**C**
AI	2,26±0,104	11,265	2,25±0,088	9,601
LPS	14,19±0,135*	2,337	13,76±0,109*	1,945

***p<0,05**

The atherogenic index of milk was calculated using an equation expressing the percentage ratio of fatty acids - lauric, myristic and palmitic, to the amount of monounsaturated and polyunsaturated fatty acids. For the milk of Tetevenska sheep, AI value was found to be 2.26, and for Kotlenska sheep - 2.25. The indicators are close and do not allow for breed differentiation, but allow an assessment of the possibility of healthy eating and prevention of various diseases. Markova, (2019) reported results close to ours when examining the milk from Koprivshtitsa sheep - 2.22, whereas the results for Srednostaroplaninska sheep were higher than ours - 2.71. A higher AI value of 2.68 was found by Naydenova et al., (2013) in a study of buffalo milk.

The lipid preventive score (LPS) is an index used to evaluate the preventive effect of a given fat, taking into account its lipid content and its composition of polyunsaturated, monounsaturated and saturated fatty acids. The lipid preventive score makes it possible to classify and choose foods with the aim of better prevention of cardiovascular diseases.

In the milk of Tetevenska sheep, the LPS index has a significantly higher value - 14.19, compared to the same in Kotlenska sheep -13.73. The obtained values for LPS are higher than those reported by Ivanova et al., (2017) in BWD goats – 8.99 and those reported by Naydenova et al., (2013) in the study of milk from Bulgarian Murra buffalo breed -12.42 .

We can speak of an optimal balance of the fatty acid composition of milk when the values of the main groups of fatty acids are such that the lipid preventive score is close to or equal to the total fat content (TL). The consumption of fats, in which the LPS and TL values are equal or as close as possible, is useful in view of its preventive effect, in relation to the risk of cardiovascular diseases. This is of great importance for the evaluation of products from the point of view of their nutritional value and safety, for which the balance of the fatty acid composition is important (Mihaylova, 2006).

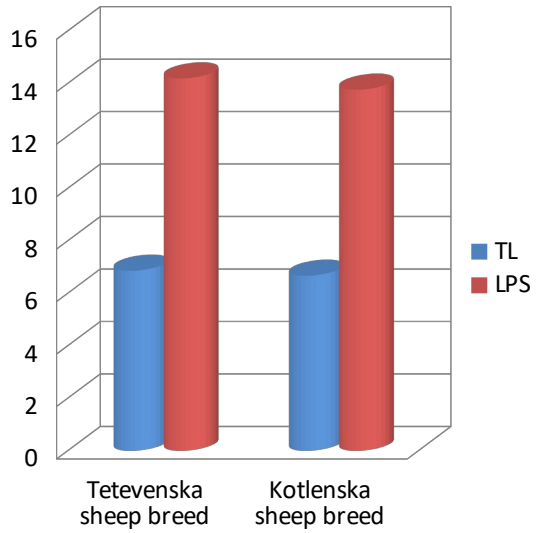


Fig 4. Lipid preventive score and total lipids in milk from Tetevenska and Kotlenska sheep breeds.

The present research show that the difference in the values of LPS and TL in Tetevenska milk is greater - 7.33, compared to 7.09 in Kotlenska milk, therefore, better indicators of LPS and fatty acid balance have the milk of Kotlenska breed sheep. (Fig. 4). In studies on the fatty acid composition in the milk of Tsigai and Karakachan sheep, Mihaylova (2006) found a difference in the LPS and TL values - 8.1 and 8.4, respectively.

Task 7. To determine wool yield and fleece pigmentation in Tetevenska and Kotlenska sheep breeds

The established values for the average wool shear in sheep of Tetevenska and Kotlenska breeds and of different ages are reflected in Table 20.

Table 20. Wool production of ewes at different age and breeds in kg

Age / Breed	n	2.5 years		3.5 years		4.5 years	
		x±Sx	C	x±Sx	C	x±Sx	C
Tetevenska	15	2,26±0,07	12,27	2,07±0,10	19,33	2,01±0,09	17,72
Kotlenska	15	2,69±0,05	6,67	2,46±0,06	8,83	2,27±0,10	19,23

p>0,05

2.5-year-old Tetevenska ewes have an average wool production of 2.26 kg, as Kotlenska sheep is with 2.69 kg, the difference being mathematically proven (20.05). The established levels of wool production are in accordance with those indicated by Yordanov et al., (2017) and are significantly lower than those reported by Genkovski, (2002) for Tetevenska sheep - 3.03kg. It is possible that this is due to unequal feeding and rearing conditions in different years. It is noteworthy that the variation of the sign in the 2.5-year-old Kotlenska ewes is the lowest - 6.67%, compared to the one found for Tetevenska ewes -

12.27% at the same age. The highest variation is found in 4.5-year-old Tetevenska ewes with 19.33% and for 4.5-year-old Kotlenska ewes is 19.23%.

For the following years, a slight decrease in shearing was observed, as in 3.5-year-old Tetevenska ewes it was 2.07 kg, and at 4.5-year-old ewes is 2.01 kg, and in Kotlenska sheep 2.46 kg and 2.07 kg respectively (Figure 5), and the variation is multidirectional in terms of values. From the data in the table, it is clear that the sheared wool of Kotlenska breed at 2.5 years and 3.5 years of age is higher than that of Tetevenska breed, and at 4.5 years the results, both for the quantities and for the variation, equalize .

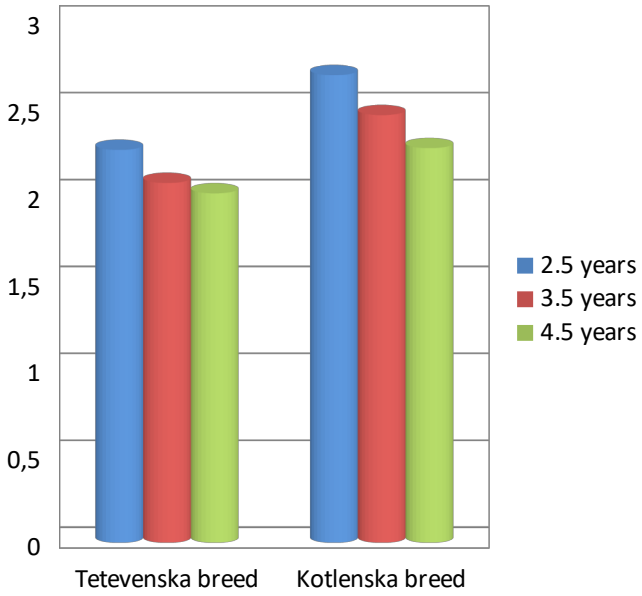


Fig 5. Wool yield for different ages and breeds (kg

Data on the natural wool length of the sheep included in the study of both breeds of different ages are reflected in Table 21.

Table 21. Natural wool length of ewes at different ages from Tetevenska and Kotlenska breeds. (cm)

Age / Breed	n	2.5 years		3.5 years		4.5 years	
		x±Sx	C	x±Sx	C	x±Sx	C
Tetevenska	15	15,13±0,61	14,61	14,80±0,43	10,48	13,60±0,65	17,33
Kotlenska	15	15,90±0,25	5,57	15,03±0,34	7,6	14,00±0,43	10,48

p>0,05

2.5-year-old Kotlenska ewes have the largest natural wool length - 15.90 cm, which exceeds that of Tetevenska sheep (15.13 cm) by 1.14 cm or by 4.8 %. At the age of 3.5 years, the natural wool length slightly decreases and at the age of 4.5 years, it significantly decreases by 1.47 cm in Kotlenska breed and 1.53 cm in Tetevenska breed. The established differences between the breeds according to the research traits are in favor of Kotlenska ewes for all ages studied. Genkovski, (2002) reports lower than our results for 2.5-year-old Tetevenska ewes

with natural wool length of 12.93cm, at 3.5 years - 13.48cm and at 4.5 years - 12.40cm

Variation both by breed and by age is insignificant, an increase with age is observed, the most significant being 17.33% in 4.5-year-old Tetevenska sheep. It is possible that the observed decrease in wool length is due to a shortening of the period between shearing campaigns.

The actual fiber length of the wool is of great importance to the textile industry. This is the length measured from the root of the fiber to its tip, measured to the nearest 0.1cm. To establish the actual length, the fiber is carefully straightened to a perfectly straight line without pulling and measured. There is always a difference between natural and true length. The curlier the fibers (with more curls per 1cm of natural length), the greater the difference. The ratio between the natural and true length of the fibers is called "degree of curling".

In the case of the mixed non-uniform wool, which is obtained from both studied breeds, two lengths were measured - the length of the awn-like and the length of fluffy fibers.

The measured actual length of individual fiber types in Tetevenska and Kotlenska breeds is presented in Table 22.

Table 22. Actual length of fleece fibers by types and breeds in (cm).

Breed / **Types Fibers**	**Tetevenska**			**Kotlenska**		
	n	**x±Sx**	**C**	**n**	**x±Sx**	**C**
Fluff	16	7,88±0,06	2,84	100	7,62±0,04	5,57
Transitional	1329	14,40±0,04	12,00	1442	14,25±0,05	15,14
Awn-like	583	17,20±0,07	0,98	175	17,84±0,03	2,09

It was found that the fluffy fibers in Kotlenska sheep are shorter in length compared to those in Tetevenska sheep, respectively – 7.62cm and 7.88cm. The shorter length is compensated by the higher number of fibers found in the samples.

The transitional fibers in Tetevenska sheep are longer than the fluffy fibers in Kotlenska sheep. Longer awn-like fibers were found in Kotlenska sheep fleece - 17.84 cm, compared to Tetevenska sheep, but their number in the studied samples was significantly lower in Kotlenska sheep.

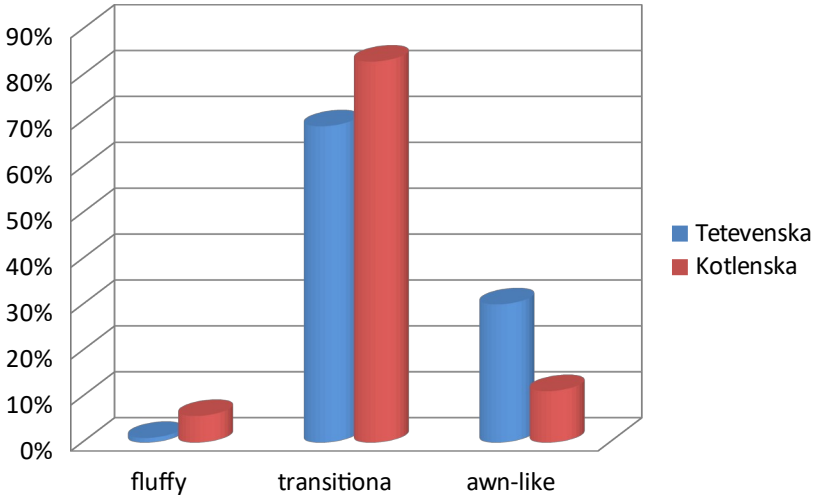


Fig 6. Relative share of fiber types in fleece of Tetevenska and Kotlenska sheep breeds (%)

Fluffy fibers make up 6% of the fleece of Kotlenska sheep, while the share of down fibers is only 1% in Tetevenska sheep (Figure 6). Transitional fibers occupy the largest share of the fleece - Tetevenska with 69%, compared to 83% in Kotlenska breed. The relative share of awn-like fibers is completely different with 11% of the fleece in Kotlenska sheep breed and 30% of the fleece in Tetevenska sheep breed. The wool of Tetevenska sheep is coarser.

Analyzing the results for the natural and true wool length, we found that there were no significant differences within the groups. The natural and true wool length of Kotlenska breed of sheep is greater compared to the same indicators of Tetevenska sheep breed.

Table 23. Thickness of diffirent fiber types in sheep fleece in microns

Types fibers / Topographic Area	Fluffy fibers		Transitional fibers		Awn-like fibers		Thick awn-like fibers	
	x±Sx	C	x±Sx	C	x±Sx	C	x±Sx	C
Tetevenska								
– shoulder	27,25±0,45	7,18	40,42±0,59	6,75	58,81±0,81	6,05	76,69±1,37	3,76
– side part	25,91±0,64	6,59	39,93±0,58	6,48	58,51±0,70	6,8	75,26±4,25	6,34
– leg	26,28±0,39	6,55	40,85±0,44	9,7	58,89±0,65	5,02	79,25±3,24	4,47
Kotlenska								
– shoulder	25,50±0,81	17,04	38,40±0,93	14	59,48±0,73	6,25	79,90±0,66	2,3
– side part	24,45±0,47	12,92	38,86±1,14	19,38	59,69±0,89	17,04	78,25±2,12	11,4
– leg	25,35±0,48	6,43	40,60±0,87	9,81	60,50±1,34	9,8	77,33±±2,14	11

p>0,05

The thickness of fluffy and transitional fibers in the fleece of Tetevenska and Kotlenska sheep varies topographically within insignificant limits, but in Tetevenska sheep they are of greater thickness (Table 23). Awn-like and thick awn-like fibers are thicker that Kotlenska sheep's fleece. In the given case, if the percentage ratio of different types of fibers is not taken

into account, the statement will be false, due to the fact that the percentage of awn-like fibers is very different - 10.2% for Kotlenska breed and 30.1% for Tetevenska breed, which confirms the conclusion , that the wool of the sheep of Tetevenska breed is coarser than that of Kotlenska sheep breed.

Fleece pigmentation

The following colour shades are accepted for visual assessment of wool and hair coat:

- White
- Black
- Grey /usually obtained from the combination of white and black hairs/
- Beige /light brown/
- Red - carmine /with shades from light to dark/
- Light red /yellowish or ten pigment/
- Brown

To objectify the evaluations, a special standard developed by Veda Institute of Research and Technology, Department of Coloristics, was used for the purposes of selection (Aleksieva et al., 1998). The differences among black, brown and red colour were the result of differences in the genetic control of the synthesis of eumelanin and pheomelanin and differences in the shape and size of the pigment granules (Nedelchev, 1989).

A great diversity is observed in pigmentation of Tetevenska sheep, both on the body, as well as on the head and limbs. Of the estimated 44 animals, 26 have white fleece, whereas 13 sheep are brown, 2 sheep are black and gray, and 1 sheep is light brown (Table 24).

Table 24. Pigmentation of Tetevenska ewes

No in order	Body	Head	Legs
1	brown	black	black
2	white	black spots over 10 cm	black spots up to 10 cm
3	brown	black	black
4	brown	black	black
5	brown	black	black
6	white	black spots over 10 cm	black spots up to 10 cm
7	white	white	black spots up to 10 cm
8	brown	black	black
9	white	white	white
10	white	black spots up to 10 cm	black spots up to 10 cm
11	brown	black	white
12	white	black spots up to 10 cm	black spots up to 10 cm
13	white	black spots up to 10 cm	black spots up to 10 cm
14	brown	black	black
15	grey	black	black
16	brown	black	black

17	brown	black	black
18	white	black spots up to 10 cm	black spots up to 10 cm
19	brown	black	black
20	white	white	white
21	white	black spots over 10 cm	white
22	white	light brown	light brown
23	white	black spots up to 10 cm	black spots up to 10 cm
24	white	black spots up to 10 cm	black spots up to 10 cm
25	white	black spots up to 10 cm	black spots up to 10 cm
26	white	black spots up to 10 cm	black spots up to 10 cm
27	white	black spots up to 10 cm	black spots up to 10 cm
28	brown	black	black
29	white	grey spots up to 10 cm	grey
30	brown	black	black
31	brown	black	black
32	grey	black	black
33	white	black spots over 10 cm	black spots up to 10 cm
34	white	black spots over 10 cm	black spots up to 10 cm
35	white	black spots over 10 cm	black
36	white	black spots up to 10 cm	black spots up to 10 cm
37	white	white	white
38	black	black	black
39	white	grey	grey
40	light brown	black	black
41	white	grey	grey
42	white	black spots up to 10 cm	black spots up to 10 cm
43	black	black	black
44	white	black spots over 10 cm	black spots over 10 cm

There is also a great variety, both in the colour of the spots on the head, and in their size and shape. For the needs of the research according to criteria developed by Genkovski (2002), the size of the spots is conventionally indicated by the size of a 10-cent coin (~18 mm). Of the examined ewes, 59% have a white fleece colour. In the case of pigmented ones, the variety is large, from black to light brown. There are individual animals with a combined fleece colour - white and black or brown (Fig. 19). Grey colour comes in different shades from light grey to bluish grey. Animals with a pigmented head predominate and only 1% have a white head, 43% have black or white spots, 40% have a black head, 2 are gray in color and one is light brown. The colouring of the legs is about the same as the pigmentation of the head.

Genkovski (2002) observed a similar distribution of colour in Tetevenska sheep, reporting that 50% of Tetevenska offspring had white wool.



Fig 7. Different fleece colours in Tetevenska sheep breed

Table 25. Pigmentation of Kotlenska ewes

No in order	Body	Head	Legs
1	brown	black	black
2	brown	black	black
3	brown	black	black
4	brown	black	black
5	brown	black	black
6	brown	black	black
7	brown	black	black
8	brown	black	black
9	brown	black	black
10	brown	black	black
11	grey	black	white
12	brown	black	black
13	brown	black	black
14	white	black spots up to 10 cm	black spots up to 10 cm
15	brown	black	black
16	white	black spots over 10 cm	black spots up to 10 cm
17	white	black spots up to 10 cm	black spots up to 10 cm
18	grey	black	black

19	grey	black	black
20	brown	black	black
21	brown	black	black
22	brown	black	black
23	brown	black	black
24	brown	black	black
25	brown	black	black
26	brown	black	black
27	brown	black	black
28	brown	black	black
29	brown	black	black
30	brown	black	black
31	brown	black	black
32	brown	black	black
33	brown	black	black
34	brown	white spots over 10 cm	black
35	brown	black	black
36	brown	black	black
37	brown	black	black
38	brown	black	black
39	brown	black	black
40	brown	black	black
41	brown	black	black
42	brown	black	black
43	grey	black	black
44	brown	black	black

In the studied 44 animals of Kotlenska breed, the animals with pigmented fleece take a significant advantage, as brown are 37 (or 84%), 9% are grey and only 7% are white (Table 40). In the pigmentation of the head, 90% are black and only 10% have spots. The same is observed in the colour of the hair coat on the legs, which usually matches the colour of the hair coat on the head, as 93% have black legs and 7% are spotted. Animals with pigmented fleece outnumber others. There are animals with pigmentation from white, gray-brown to black, tricolor (Figure 8) (similar to the coloration of the male mouflon) - white, red-brown and black or bicolor in all color combinations animals (Figure 9).



Fig8. Kotlenska lamb with tricolour pigmentation



Fig 9. Different fleece colours in Kotlenska sheep breed

Task 8. To monitor farms raising Tetevenska and Kotlenska sheep breeds.

Sheep of both breeds are a valuable genetic resource. They are included in the Ministry of Agriculture's list of endangered species. In their current form, they are part of the cultural heritage of the regions in which they are seen and due to their small number, they are defined by the FAO as at risk (Dimov, 2001). In 2002, in the Republic of Bulgaria, at the initiative of FAO, monitoring of the national gene pool in animal husbandry was conducted. The studies are directed in two directions - characteristics of the breeds and evaluation of the production system in which the herds function.

Table 26 presents some characteristics of the production schemes in which animals from Tetevenska and Kotlenska breeds are bred.

Table 26. Monitoring of sheep farms of the local sheep breeds - Tetevenska and Kotlenska, where support selection is conducted.

Indicators / Breeds	Number of sheep in herds								Service		Other activities	
	50-100	100-150	150-200	200-250	250-300	300-350	350-700	Over 1000	With assisstant	Without assisstant	Yes	No
Tetevenska	14	9	4	6	2	-	-	-	22	13	17	18
Kotlenska	15	16	9	4	1	2	1	2	19	31	19	31

The size of Tetevenska breed herds, in which breeding and selection work is conducted by the breeding organizations, varies widely - from 50 pcs. up to 300 pcs. sheep in a flock. The largest number are herds in which up to 100 ewes are raised - 14. (almost 1/3 of the controlled herds) and only two are the herds up to 300 pieces. For Kotlenska breed, the variation in the number of sheep in the flocks is much wider - 15 families breed up to 100 sheep, and over 300 - 5 farmers, of which two take care of over 1000 sheep. In most cases, a family member is involved as an assistant, who is also involved in other activities - taking care of other types of animals, participating in harvesting and preparing fodder, etc.

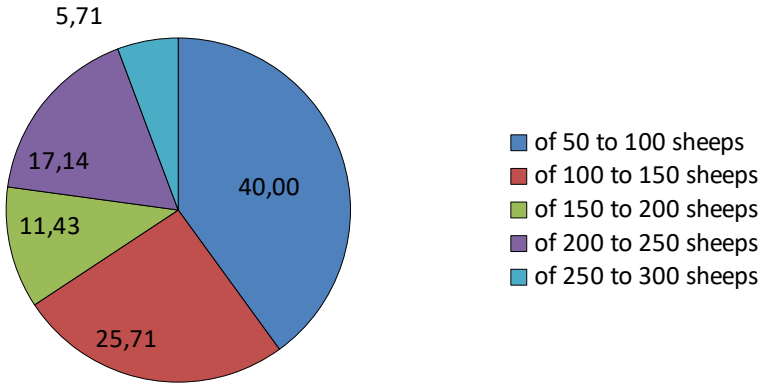


Fig10. Structure of Tetevenska breed by herd size in %

There were 4.560 animals of Tetevenska sheep breed, distributed in 35 herds till 01.01.2021 Figure 10 shows that Tetevenska sheep breed had the largest share (65.71%) of the population raised in small flocks of 50 to 150 sheep.

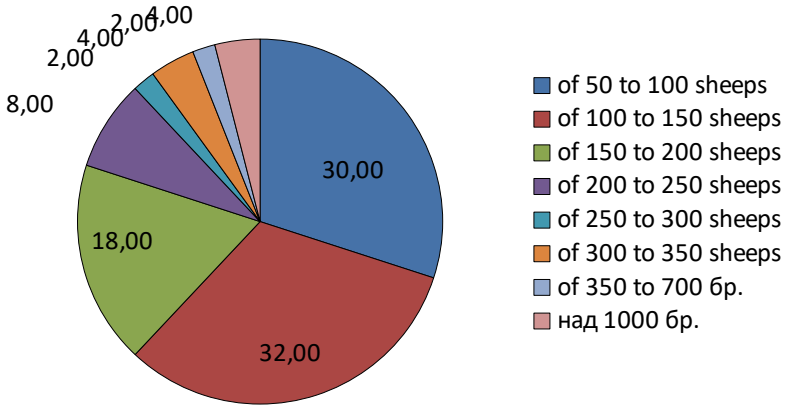


Fig11. Structure of Kotlenska breed by herd size in %

There were 9289 Kotlenska animals till 01.01.2021, distributed in 50 flocks, as the largest part of 62% was occupied by flocks from 50 to 150 animals. The smallest - 2% is the share of two of the flocks in which the number of sheep is just over 1000 (Fig. 11).

There is a distribution of Tetevenska and Kotlenska animals in relatively small flocks (Figures 10 and 11). The reasons are probably the labour intensity of the industry, the lack of sufficient manpower and unattractiveness for young people. Livestock breeders prefer to raise a smaller number of sheep, which allows for one flock to be cared for by only one person most of the time.

The rearing of a small number of animals provides an opportunity for better tracking of the origin of the animals, and from there, the carrying out of breeding activity with high accuracy.

Insemination of sheep is natural in most cases by hand. Owners are obliged to use purebred male sires with good breeding value. The sheep breeder is obliged to register the day of insemination and the ram, and the data are recorded in a special notebook.

In the summer, most of the sheep are taken to the camp (mountain pasture) to free up the meadows and pastures close to the farms. The camping of the animals has a positive effect on their body condition, and in a short period of time they get breeding condition. Most of the sheep are being milked. The milk produced on the mountain pasture is processed into cheese. At the end of lactation, the produced milk is in some cases processed into salt in the so-called qatic.

Task 9. To establish the economic efficiency of raising Tetevenska and Kotlenska sheep breeds.

Establishing the economic efficiency of raising particular breeds of sheep has not only scientific, but also important practical significance. The developed methodical approach for calculating the economic efficiency for individual breeds of sheep will help farmers and owners to quickly and better navigate depending on the specific conditions, what breeds and how many sheep to breed.

It is essential whether the feed is entirely self-produced or part of it is purchased. When analyzing the prices of feed, it is noticeable that the price of concentrated feed and hay of own production (at cost price) is 10-20 cents lower than the market price. Here, the degree of mechanization of the production processes, mainly harvesting, mowing, transport and processing before planting, has a great influence. At present, most of the farmers have not been able to acquire machinery to fully mechanize the processes for the production, storage and processing of fodder.

- Other material costs include those for depreciation, treatment, prevention, insurance, water, electricity, salt and others.

- The Salary Fund is established according to the actual salary of an employee, which includes insurance. Most of the farmers prefer to provide themselves with a minimum wage.

- The net income is established without and with the applicable subsidies for the selection of endangered local breeds of sheep.

- The profitability rate is calculated by dividing the net income by the amount for the total production in percentage.

The production and economic results by breed are calculated for one structural ewes together with the lamb until its realization.

The calculated production and economic results of raising both breeds in the conditions of the Central Balkan Mountain - Tetevenska in the north and Kotlenska in the south are shown in Tables 27 and 28.

Table 27. Production and economic results for year-round breeding of Tetevenska ewes with combined direction

Indicators / Norms		Of one ewe		
		Amount	**Unit value**	**For one year (lv)**
1	**Total production**	-	-	245,60
	– Milk (l)	62	1,30	80,60
	– Meat (kg)	27	6,00	162,20
	– Wool (kg)	3	1,00	3,00
2	**Material costs**	-	-	175,00
	– concentrated feed (kg)	120	0,60	72,00
	– hay (kg)	180	0,35	63,00
	– green fodder (kg)	700	0,01	7,00
	– medicine	-	-	18,00
	– electricity	-	-	5,00
	– other	-	-	10,00
3	**Salary Fund with State Social Insurance (lv)**	0,30	9,00	108,00
4	**Production (lv)**	-	-	283,00

5	**Net income (lv)**			-37,40
6	**Profitability rate (%)**			-15,22
7	**Net income with subsidies**	80,00	80,00	42,60
8	**Profitability rate with subsidies (%)**			13,09

Table 28. Production and economic results for year-round breeding of Kotlenska ewes with combined direction

Norms / **Indicators**		**Of one ewe**		
		Amount	**Unit value**	**For one year (lv)**
1	**Total production**	-	-	220,20
	– Milk (l)	47	1,30	61,70
	– Meat (kg)	26	6,00	156,00
	– Wool (kg)	2,5	1,00	2,50
2	**Material costs**	-	-	175,00
	– concentrated feed (kg)	120	0,60	72,00
	– hay (kg)	180	0,35	63,00
	– green fodder (kg)	700	0,01	7,00
	– medicine	-	-	18,00
	– electricity	-	-	5,00
	– other	-	-	10,00
3	**Salary Fund with State Social Insurance (lv)**	0,30	9,00	108,00
4	**Production (lv)**	-	-	283,00
5	**Net income (lv)**			-62,80
6	**Profitability rate (%)**			-28,5

7	**Net income with subsidies**	80,00	80,00	17,20
8	**Profitability rate with subsidies (%)**			5,73

From the data presented in Tables 27 and 28 it is clear that the economic efficiency in both breeds is low. The net income per head ot Tetevenska sheep is 37.40 BGN without subsidies and BGN 42.60 with subsidies, whereas for Kotlenska is 62.80BGN without subsidies and 7.20 BGN with subsidies, respectively.

Economic performance without subsidy is a prerequisite for a substantial reduction in the total number of sheep in stock flocks and is not able to ensure extended reproduction.

The low efficiency is primarily due to the outpacing rates of growth in the prices of production costs - material and labor, compared to the growth in the prices of sheep farming production. In most cases, the latter over the years remain at the same level, and in some cases they rise slightly. From the analysis of economic efficiency, it can be concluded that at the current prices of sheep products and the values of production costs, farmers have no interest in raising sheep in commodity flocks and carrying out extended reproduction, due to a significant increase in losses.

The full use of the vast territories of pastures and meadows in the foot-hill and mountain regions of the Balkan Mountains and in the mountains in general is unthinkable without creating significant economic incentives, motivation and mechanisms to attract people to raise sheep. It is imperative to prepare a National program for the development of animal husbandry, including sheep farming for the foot-hill and mountain regions, in which the more difficult conditions for production and extraction of the most ecological and healthy production possible, for which preferential prices are to be provided, will be reflected.

V. CONCLUSION

The analysis of the results of the comparative studies of the breeding herds, in which breeding and selection work is carried out with the sheep of Tetevenska and Kotlenska breeds, allows the following conclusions to be drawn:

1. The average live birth weight of lambs is about 3.00 kg. Offspring of Tetevenska breed at birth are on average 0.420 kg heavier than those of Kotlenska breed. The variation of the average live weight values at all ages is within relatively narrow limits, and until the age of 4.5 years, the superiority of Tetevenska breed animals is preserved.

2. The exterior measurements of the mature sheep show that Tetevenska ewes outperform Kotlenska breed in all body parameters. Based on the values of the indices obtained, it was found that Kotlenska animals are smaller with a more compact body and a stronger bone system, while Tetevenska sheep are taller, with a longer body length, which is a prerequisite for we justify that they have the potential for higher milk yield compared to Kotlenska ewes.

3. In both indigenous sheep breeds, three types of dermatoglyphs occurred, such as "Granular", "Furrow" and "Cross". Breed and morphometric differences were found in the distribution of dermatotypes and the values characterizing the area of the nasolabial plate and the length of the furrows. The percentage share of dermatotypes in Tetetevenska sheep shows the highest values for "Granular" dermatotype with 47.5%, followed by "Furrow" with 40%, and the smallest value in percentage terms is for "Cross" with 12.5%. For Kotlenska sheep, the share is 52.5% for "Furrow", followed by "Granular" with 25%, and "Cross" again had the

lowest values with 22.5%. Higher values for the nasolabial plate area and the length of the furrows forming fragments, are found Kotlenska breed.

The direction of furrows and the amount of skin fragments are hereditarily determined and there is no relation to the post-embryonic development of sheep.

4. The economic fertility for the investigated three-year period in both breeds is below 100%. Tetevenska sheep, it varies from 94.36% in 2019 to 98.52% in 2021, and for Kotlenska sheep, respectively, from 90.3% in 2019 and 96.2% in 2020. Biological fertility in both breeds is relatively high – varying within very wide limits from 101.0% in 2021. It was up to 128.35% in 2019 for Tetevenska breed and respectively 102.0% in 2018 and 103% in 2021 for Kotlenska breed. Research on biological and economic fertility depending on the age of Tetevenska ewes varies from 109.9% of the first lamb to 121.49% of the second, as for Kotlenska sheep it is from 107.83% of the first lamb to 111.18% in the second one. Economic fertility by age is relatively high in Tetevenska sheep and for all three years it was slightly over 100%, as the results for Kotlenska sheep were slightly lower, in the first lamb it was 99.03%, and in the second and third it was over 100%.

5. The established growth capacities of young female animals of both breeds showed that growth intensity and changes in live weight under traditional rearing conditions were of an intensity providing well-developed animals for breeding. Male tetevenska lambs have the highest growth rate compared to male Kotlenska lambs. Their average daily gain is 0.250kg. Female Tetevenska lambs also have 15% higher growth compared to female Kotlenska ones.

The feed consumption in FUG and PDI per 1 kg of growth was the lowest in Tetevenska male lambs (3.93 KEP and 611 g PDI), where it was the highest in Kotlenska female lambs (5.77 FUG and 897 g PDI). The female Tetevenska lambs consumed 16.29% less FUG and 16.27% less PDI per 1 kg of growth than the female Kotlenska lambs.

Female Tetevenska lambs have the highest percentage of carcass weight after 24-hour cooling, relative to pre-slaughter weight - 40.38%, and male lambs from the same breed have the lowest - 36.77%.

When cutting the carcasses into parts, according to the methodology adopted in our country, it was found that the heaviest weight and the largest relative share in all investigated groups of animals was the leg.

The meat yield ratio is the highest in female Tetevenska lambs – 1:3.04, followed by that of male Kotlenska lambs 1:2.808 and the lowest in females of the same breed – 1:2.46.

6. The difference between the average daily milk yield is in favor of Tetevenska sheep - 16.92% The milking milk production of the sheep of the Tetevenska breed is relatively high - 59,960 l and is greater than that of Kotlenska breed by 16.06%.

When determining the physicochemical parameters of the milk from the two breeds for dry matter content, no significant difference was found. The situation is similar with the content of fatty substances.

The determined values for SNF, protein, lactose, casein, non-casein protein, density and acidity are without significant differences.

The amount of macroelements, expressed as percentages of Ca and P, are slightly higher in the milk of Tetevenska sheep. For the rest (K and Mg) the results are close. In the ratio for the content of microelements F, mg/kg and Zn, mg/kg, a minimal superiority was found for the Tetevenska breed, and the reported values for the Mn content were the same and only the values for Cu, mg/kg in the milk of Kotlenska sheep were higher.

The amounts of saturated fatty acids in milk fat are significant in both breeds. The percentages of short-chain fatty acids - butyric, caproic and caprylic acids are higher in the

milk fat of Tetevenska sheep, while in Kotlenska sheep, capric acid is superior to that of Tetevenska sheep.

Sheep milk from Tetevenska and Kotlenska breeds is characterized by a high fat content of 8.17% and 8.13%, respectively, and proteins 6.46% and 6.61%, which guarantees that it is a good raw material for the production of white brine cheese.

The produced cheese is characterized by a high fat and protein content, which guarantees a good nutritional and biological value. Its preparation coincides with feeding the sheep with pasture grass, which guarantees the natural nature of its composition. Ripeness is confirmed by the observed increase in dry matter content, drop in water content and increased acidity of the finished product.

7. The wool of Tetevenska and Kotlenska sheep breeds is coarse, non-uniform, with the presence of three types of fibers - fluffy, transitional and awn-like.

The wool yield of the ewes by breed and age ranges from 2.01kg per 4.5-year-olds to 2.26kg per 2.5-years for Tetevenska sheep and from 2.07kg for 4.5-year-olds to 2.69kg per 2 ,5 year old Kotlenska sheep There is a slight decrease in the average shear wave with increasing age.

2.5 year-old Kotlencка ewes had the largest natural wool length, and at all ages according to this indicator they exceed the results of Tetevenska ewes.

The true wool length, formed by the ratio of fluffy to awn-like fibers, in Kotlenska sheep is predominantly fluffy, and in Tetevenska sheep, predominantly awn-like. The results show that the wool of Tetevenska sheep is significantly coarser than that of Kotlenska sheep.

In the present research on the fleece colour, it was found that 59% of the examined Tetevenska sheep have white fleece, whereas only 16% of Kotlenska sheep have white colour. Pigmentation on different parts of the body varies from white, grey, light brown, brown and black in various shades

8. The monitoring of the production schemes in which sheep from Tetevenska and Kotlenska breeds are raised shows that the average size of the flocks in which breeding and selection work is carried out varies widely. The largest number of farmers grow up to 100 Tetevenska animals - almost 1/3 and only three of them up to 300 animals. For Kotlenska breed, the variation in the number of animals in the herds is much wider - 15 farmers breed up to 100 animals, and 5 farmers over 300, of which two take care of over 1000 sheep.

9. The economic efficiency of raising sheep of both breeds is low. The net income per head for Tetevenska breed is 37.40 BGN, without subsidies and 42.6 BGN profit with subsidies, and for Kotlenska breed is 62.80 BGN without subsidies and 17.20 BGN profit with subsidies.

VI. RECOMMENDATIONS

1. To continue breeding and selection work according to the method of maintenance selection, according to the Breeding Program with a view to preserving the genetic resources.
2. The animals should be raised primarily in the natural geographical area, to which they show excellent adaptability to the natural and forage conditions typical for them (the Central Balkan Mountain).
3. Business activity should be aimed at increasing economic efficiency, through:

- increasing economic fertility (protection of offspring)
- improving nutrition
- increase in milk yield

- production of trademarked products (organic meat and milk, and their products)

4. Organization of business associations of sheep breeders for the milking period for joint grazing, processing and sale of production from the Teteven and Koten regions.

5. The established levels of productive indicators, exterior measurements and indices to serve in updating the breeding programs, also to serve as a criterion for evaluating the typicality of the animals and the effectiveness of the applied selection.

VII. CONTRIBUTIONS

1. The level of the main productive traits in sheep from the Tetevenska and Kotlenska breeds has been established. The obtained results will be used to update the breeding programs, and will serve in the selection of the right approaches in the direction of maintenance and improvement of the two breeds of sheep threatened with extinction - **An original contribution of scientific and practical importance**.

2. The growth, fattening and slaughter qualities of lambs from the Tetevenska and Kotlenska breeds have been established. **- A contribution of scientific and practical significance**

3. The chemical composition, macro- and microelements, as well as the content of saturated and unsaturated fatty acids in the meat of lambs from Tetevenska and Kotlenska breeds were studied. Original contribution of scientific and practical significance.

4. The indicators, such as Atherogenic index and Lipid preventive score in the milk of Tetevenska and Kotlenska sheep were studied. **Contribution of scientific and practical significance.**

5. Breed and morphometric differences were found in the distribution of dermatotypes and the values characterizing the area of the nasolabial plate were determined. **- Original contribution of scientific and applied significance.**

VIII. DISSERTATION RELATED PUBLICATIONS

1. Nikolova, Tsv., 2019, Dermatoglyphic characteristics of the nasolabial plate of Tetevenska and Kotlenska indigenous sheep breeds. Journal of Mountain Agriculture on the Balkans; 2019, Vol. 22, Number 2, p50-59, 10p. 22, Number 2, p50-59, 10p.

2. Nikolova Tsv., Markov N., Tsochev Iv., 2023, Pigmentation of the fleece of the local sheep breeds - Tetevenska and Kotlenska, Journal of Mountain Agriculture on the Balkans Vol.26, Number 1, p119-128p, 10p.

GENOTYPE AND PHENOTYPE PARAMETERS OF SHEEP FROM THE KOTLEN AND TETEVEN BREEDS AND POSSIBILITIES FOR EFFECTIVE SUPPORTING SELECTION

Summary

The purpose of the present dissertation is to determine the parameters of the productive sighs and possibilities for effective maintenance selection of the sheep from the Tetevenska and Kotlenska breeds.

The information obtains more correct formulation of the breeding programs and selection criteria of the breeding organizations for the respective breeds. It will help in the selection of effective maintenance breeding schemes to converse the geno pool and prevent the extinction of these two indigenous sheep breeds.

The experiments were conducted in 2018-2021. They include 395 sheep and 18 rams from the purebred Teteven herds, bred in the region of Teteven municipality, 384 sheep and 13 rams of Kotel and Sliven region. 96 lambs of all these farms were included, too.

The following researches have been conducted to track the dynamics and growth of the sheep at different age. They have established that the Teteven lambs were born with a higher weigh than the Kotlen ones. The Teteven sheep have a high live weigh.

Exterior measurements of adult sheep were done and exterior indices were calculated. Through them it was established that the Kotlen sheep are smaller with a more compact body and a strong bone system, but the Teteven sheep are taller with a long body.

The researches of the dermatotypes are following:

The Kotlen sheep have a larger area of the nasal mirror with a larger blob and deeper furrows.

The biological fertility for the period 2019- 2021 was research. The results in both breeds are relatively high. They vary in the following limits: for the Tetevenska from 101.0% in 2021 to 128.35% in 2019 and 102.0 % in 2019 to 103.0% in 2021 for the Kotlenska.

An attempt has been made to study the fattening and meat – producing qualities of male and female lambs from the both breeds. The research found that the male lambs from the Teteven breed have the highest growth intensity. The male lambs from the Teteven breed have the lowest consumption of feed to achieve a kg of growth.

Milk yield has been researched and established, too. The research shows that the Tetevenska sheep have a higher milk yield than the Kotlenska ones-59,960 l, compared to the Kotlen sheep milk yield – 50, 32 l.

Wavy productivity, natural fiber length and softness were studied too. The result shows that the amount of the wool of the Kotlen sheep has higher values – 2.69kg.The wool of the Kotlen sheep has a longer natural length. The fleece consists of mainly downy fibers but the fleece of the Tetevenska sheep is mainly coarser.

Preserving the typicality of the breeds in their natural habitat should be the main goal of future breeding activity with a view to preserve the genetic potential. The economic activity should be aimed at increasing the economic efficiency by: increasing the economic fertility (protection of offsprings), improving nutrition, increasing the milk yield and producing products with a trademark.