

ASSOCIATION OF PHENOTYPIC COMBINATIONS Hb/K WITH QUALITATIVE FEATURES OF LAMB PELTS IN THE BOTOSANI KARAKUL SHEEP

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Abstract: The specific production of the sheep belonging to the Botosani Karakul breed is the one of lamb pelts, characterized by various qualitative features (shape and size of hair curls, quality, lustre and colour of hair fibres), conferring nobility to this breed and which distinguish it from other sheep breeds. The present study tries an associative analysis of these traits of lamb pelts with different combinations between haemoglobin phenotypes and potassium phenotypes. The most valuable features, concerning shape and size of hair curls, as well as the quality and lustre of hair fibres are associated with combination of phenotypes HbAB and HK, and the weakest association of these features occur with the phenotypic combination HbBB/LK. The greyish, brown, grey, pink and white colours of the hair fibres are more associated with phenotypic combination HBB/LK, and the lowest frequencies of these colours are found in phenotype HbAB associated with phenotype HK, but this last phenotypic combination is associated to the highest degree with the black colour. The differences among the empirical distributions of qualitative features of the lamb pelts in relation to all phenotypic combinations of the haemoglobin and potassium systems are very significant, fact that recommends the use of these two biochemical genetic systems for the improvement of the Botosani Karakul breed for the lamb pelt production.

Key words: haemoglobin phenotype, potassium phenotype, lamb pelt

Introduction

The great beauty, suppleness and nobility of the lamb pelts of Karakul type, conferred by the colour, elasticity and silky aspect of their hairy cover or by the remarkable design resulted from the curling degree of hair fibres, their arrangement in curls and the curl uniformity, attracted and fascinated man since ancient times. Thus, as an article of fashion, clothing made of Karakul lamb pelts currently satisfies the most

refined clothing preferences of the worldwide, especially those from countries situated in temperate and cold climate zones. The diversity of colour shades, of curl shapes and of their modelling makes from Karakul lamb pelts a natural raw material of animal origin with outstanding physical and biological features which can not be equalled or substituted by the most sophisticated modern synthesis technologies (Taftă *et al*, 1997).

Besides the determinism of other factors (nutritional, technological, climatic), the lamb pelts of Karakul type have mainly a genetic determinism, for which a large number of protein systems with structural, physiological, enzymatic role or with a cellular and extracellular vehicle function are involved.

In the mentioned context, the approach of association of the different combinations of haemoglobin and potassium types with the qualitative features of the Botosani Karakul lamb pelts did not seem without interest, with a view to use these associations in the selection and improvement processes of this sheep breed for the lamb pelt production.

Materials and Methods

The experimental works were carried out on a randomized population of 381 lambs belonging to the Botosani Karakul breed from the *Research and Production Station for Sheep Breeding, Popauti-Botosani*. The estimation of the main qualitative features of lamb pelt was performed at 24-48 hours after their birth. These features are (Taftă *et al*, 1997) (Figures 1, 2, 3, 4, 5, 6):

- the curl shape, with the characteristics: cylindrical tube, tube+grain, grain, flat tube, varia (heterogeneous and miscellaneous shapes);
- the curl size, with the characteristics: middle, middle-small, small, big;
- the quality of the hair fibre, with the characteristics: silky, normal, rough, soft;
- the lustre of the hair fibre, with the characteristics: intense, good, satisfactory, mat;
- the colour of the hair fibre, with the characteristics: black, greyish, brown, grey, pink, white.



Figure 1. Black lamb pelt



Figure 2. Greyish lamb pelt



Figure 3. Brown lamb pelt



Figure 4. Grey lamb pelt



Figure 5. Pink lamb pelt



Figure 6. White lamb pelt

The identification of haemoglobin phenotypes was made by horizontal electrophoresis method having the starch gel (12.5%), as substrate, and using a solution of Tris(hidroxymethyl)aminomethane, EDTA.Na₂ and boric acid (10/1/0,75), as electrolyte. The nomination of hemoglobin phenotypes was achieved depending on the migrating speed of the electrophoretic bands (*Hrinca, 1988*) (Figure 7).



Figure 7. Haemoglobin electrophoregram in the Botosani Karakul sheep

The determination of potassium phenotypes was performed by flamphotometric method. The K⁺ cationic concentrations of whole blood of the animals were expressed in mEq/l. Potassium phenotypes deceleration was made depending on the discontinuity space of the potassium ion distribution (*Hrinca et al, 2000*).

The experimental results were analyzed statistically. The frequencies of the characteristics of qualitative traits of lamb pelts were calculated according to the

combinations of haemoglobin and potassium phenotypes (Hb/K). The test χ^2 was used for evaluating the significance of production differences among various phenotypic combinations Hb/K by the comparison method of empiric distributions (*observed frequencies*).

Results and Discussion

The analysis of haemoglobin electrophoregrams revealed the existence of two haemoglobin patterns in the electrophoretic field in the Botosani Karakul lambs: phenotype HbA (with fast migration) and phenotype HbAB (with intermediate migration); Theoretically, it should also appear the phenotype HbA, but it is not expressed like in most sheep breeds (*Hrinca, 1988*).

The flamphotometric determinations made on whole blood in the Botosani Karakul lambs have shown that the discontinuity of blood potassium distribution was recorded between 25 mEq/l and 30 mEq/l; the individuals with up to 25 mEq/l potassium blood are of phenotype LK (with low potassium concentration), and those with more than 30 mEq/l potassium blood are of phenotype HK (with high potassium concentration) (*Hrinca et al., 2000*).

The associative analysis refers to the grouped distributional comparison of characteristics of the main qualitative traits found in the lamb pelts of Karakul type for each combination among all haemoglobin and potassium phenotypes.

Theoretically, in ovine species, there are six possible phenotypic combinations among the genetic variants of haemoglobin and potassium: HbAA/LK, HbAA/HK, HbAB/LK, HbAB/HK, HbBB/LK and HbBB/HK. In the Botosani Karakul breed, because of the absence of haemoglobin homotype HbAA, only four such combinations are expressed (HbAB/LK, HbAB/HK, HbBB/LK and HbBB/HK).

a) Association of phenotypic combination Hb/K with curl shapes (Figure 8). The curl shape is given by the special conformation and arrangement of hair fibres grouped as bundles in a certain sense and by the closure degree and curling direction of these fascicles.

The first four types of curls (“cylindrical tube”, “grain”, “cylindrical tube+grain” and “flat tube”) have been considered very valuable from economic point of view, due to the histochemical and morphological peculiarities of hair fibres as well as to the curling way of these fibres which creates a very nice and pleasant drawing on the surface of lamb pelt. Therefore, the superiority of one or other of these curls is a question of taste and fashion. If the first three curl shapes are considered traditional, the “flat tube” is a more recent phylogenetic appearance as a result of diversified practicing the selection criteria used for improvement of this breed. The fifth category of lambs have lamb pelts contain diverse types of curls (“varia”), irregularly arranged, creating a heterogeneous drawing that gives them low zoeconomic value.

The most valuable types of curls record the highest incidences in lambs with phenotypic combination HbAB/HK. The lowest frequencies of these types of curls are found in lambs in which the phenotype LK is associated with both haemoglobin phenotypes. Also, the lamb pelts of HbBB/HK association have an almost similar distribution of these curl types to those of the last two phenotypic combinations.

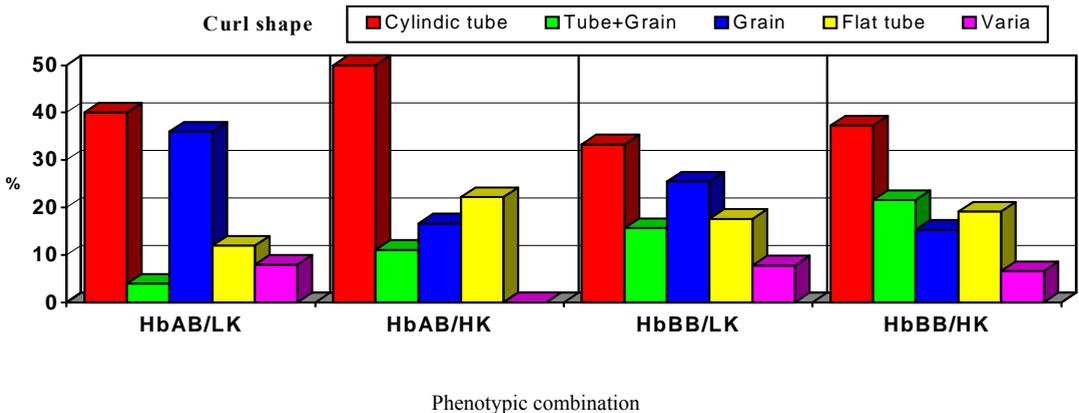


Figure 8. Incidences of curl shapes of the lamb pelts of Karakul type depending on Hb/K types

On the other hand, if the unvaluable curls of “varia” type are missing in the lambs HbAB/HK, they have an important share in the lambs with the other phenotypic combinations (especially those HbAB/LK and HbBB/LK). In fact, the lambs HbAB/HK possesses only valuable types of curls.

b) Association of phenotypic combination Hb/K with curl sizes (Figure 9). The curl size is determined by the length of component fibres, ratio between width and height of curls, diameters of these curls and their closure degree.

The first two sizes of curls (“middle” and “middle-small”) present high economic value, while the curls with extreme sizes (“small” and “big”) are undesirable traits in livestock practice of the Botosani Karakul sheep.

The valuable sizes of curls are much more frequently encountered in lambs with phenotypes HbAB and HK. Considerable frequencies of “middle” and “middle-small” curls are found in lambs HbAB/LK and HbBB/HK too. In the lambs of type HbBB/LK, these curls have the lowest distribution.

The “small” curls are the most frequently encountered in the lambs HbBB/LK. Lower frequencies, but taken into account, of these curls are in lambs HbAB/LK and HbBB/HK. The lowest incidence of “small” curls is registered in lambs HbAB/HK. The other unvaluable size of curls (“big”) is less common in population, having a low frequency in lambs HbAB/LK and HbBB/HK, a sporadic spread in lambs HbBB/LK, while in the lambs HbAB/HK this feature is missing.

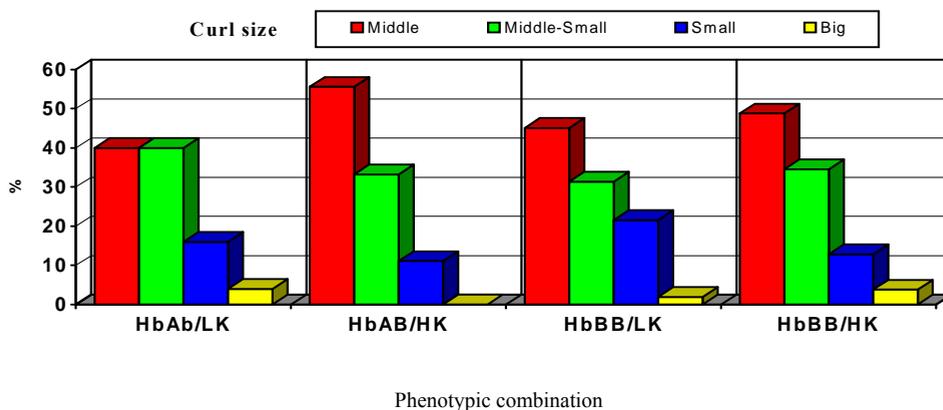


Figure 9. Incidences of curl sizes of the lamb pelts of Karakul type depending on Hb/K types

c) Association of phenotypic combination Hb/K with hair fibre quality (Figure 10). The quality of hair fibres is conditioned by the length, thickness, density, elasticity and uniformity of the component fibres of curls.

Of the four qualities of hair fibres, only the first characteristic (“silky”) corresponds, in the highest degree, to the economic exigencies, and the second feature (“normal”) is partially agreed in the selection activity, while the last two features (“rough” and “soft”) must be eliminated from the lamb populations.

The hair fibres which confer the silken aspect of the lamb pelts are the most commonly found in lambs HbAB/HK. They are followed by the lambs HbBB/HK. In the phenotype LK associated with both haemoglobin phenotypes the silken fibres have a similar proportion. In the same lambs, one third of hair fibres have “normal” quality. In the lambs with phenotype HK associated with both haemoglobin phenotypes, the “normal” hair fibres have almost the same distributions.

The hair fibres with both unvaluable qualities (“rough” and “soft”) are missing in lambs with phenotypic combination HbAB/HK. The rough fibre does not appear either in lambs HbAB/LK and HbBB/LK; the only phenotypic combination in which the rough fibres are present belongs to lambs HbBB/HK, but their presence is very low. Also, the soft fibres have a limited spread in phenotypic combinations HbBB/LK and HbAB/LK or very low in lambs of HbBB/HK type.

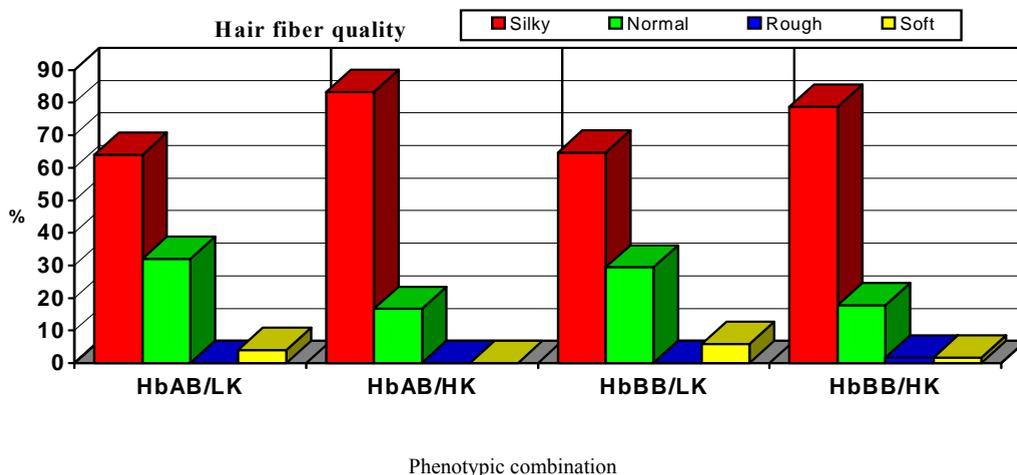


Figure 10. Incidences of hair quality of the lamb pelts of Karakul type depending on Hb/K types

d) Association of phenotypic combination Hb/K with hair fibre lustre (Figure 11).

The lustre of hair fibres expresses their ownership to reflect the light with a greater or lesser intensity. These feature depends on arrangement of fibres in curls, on surface structure of fibres and especially on the cuticle layer compactness and somehow of the cortical one of the hair fibres.

The "intense" lustre is one of the most important features of lamb pelts, but it is obtained enough difficult, its incidence being relatively low, so that the most valuable lamb pelts have a "good" lustre. The "satisfactory" lustre is more and more hardly agreed in the selection work, and the "mat" one gives a very weak quality to lamb pelts.

In the lambs HbBB/HK, one third of the lamb pelts have "intense" lustre and other two-thirds have "good" lustre. These two characteristics are very well represented also in lambs with the other three phenotypic combinations: HbAB/LK, HbBB/HK and HbBB/LK.

Both types of fibres with unvaluable lustre do not appear in lambs of HbAB/HK type. The "mate" fibres are missing in lambs of type LK associated with phenotypes HbAB and HbBB, and this fibre type is sporadically met in lambs with phenotypic combination HbBB/HK. The hair fibres with "satisfactory" lustre register low frequencies in lambs with phenotypic combinations HbAB/LK and HbBB/HK, and the incidence of this lustre type can be taken into consideration in the lambs HbBB/LK.

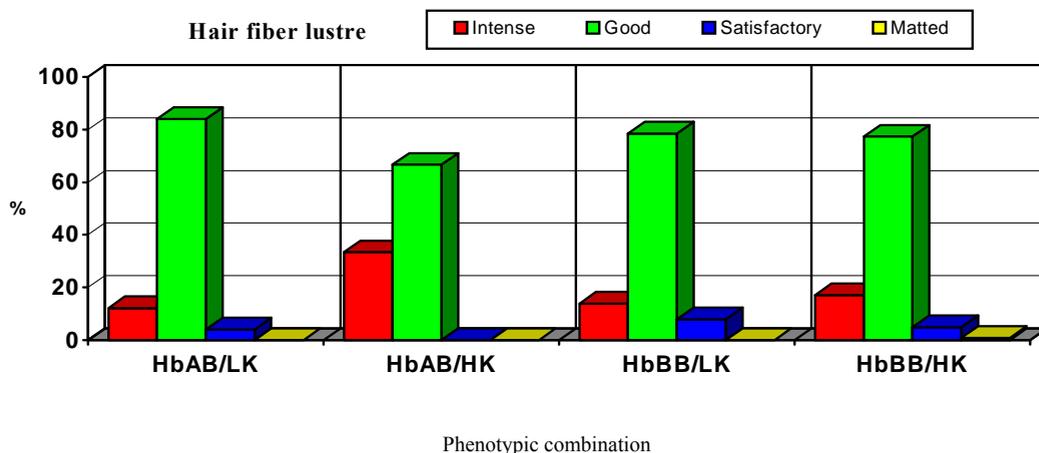


Figure 11. Incidences of hair lustre of the lamb pelts of Karakul type depending on Hb/K types

e) Association of phenotypic combination Hb/K with hair fibre colour (Figure 12). The natural colour of lamb pelts of Karakul type depends on the intensity and distribution pattern of the pigment along the fibres, both on their surface and in their histological structure.

The most important qualitative feature of the Botosani Karakul sheep is the colour of the hair fibre of lamb pelts. Six colour varieties (lines) are meeting in the Botosani Karakul breed: black, greyish, brown, grey, pink and white. The colours black and greyish are traditional (classical), and the other colours give nobleness to this breed. Due to the genetic similitude among them, as well as to their low incidence within this breed, the brown, grey, pink and white varieties were grouped in subpopulation of coloured varieties (lines).

The black line is the best associated with phenotypic combination HbAB/HK. The phenotypic combinations HbAB/LK and HbBB/HK contain a little more than 50% individuals of black line, while the lambs HbBB/LK are somewhat less spread than half of their subpopulation. The best representation of the greyish colour is in the lambs of HbBB/LK type. Important frequencies of this colour line are registered in lambs HbBB/HK and HbAB/LK. The lowest incidence of this colour line is found in lambs HbAB/LK. The coloured lines are less common in the population. The most coloured individuals are with phenotype HbBB/LK. The incidences of coloured lambs with HbAB/LK and HbBB/HK are similar, while in the individuals HbAB/HK the frequencies of these colours are the lowest.

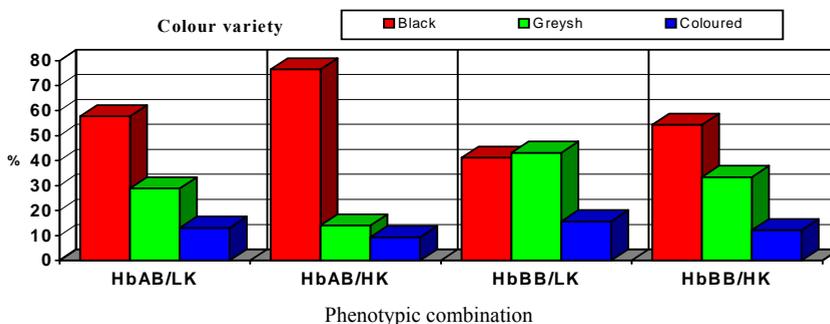


Figure 12. Incidences of hair colour of the lamb pelts of Karakul type depending on Hb/K types

From the morphological and histochemical point of view of the lamb pelts (shape and size of hair curls, quality and lustre of hair fibres), the most valuable features are associated with combination of phenotypes HbAB and HK, and the weakest association of these features occur with the phenotypic combination HbBB/LK. The phenotypes HbAB/LK and HbBB/HK present similar correlational aspects with the qualitative morphological and histochemical features of the lamb pelts.

From the colour point of view of the hair fibres, the colours which give nobleness to the Botosani Karakul breed (greyish and especially brown, grey, pink and white) are more associated with phenotypic combination HBB/LK, and the lowest of their spread is in phenotype HbAB associated with phenotype HK, but this phenotypic combination is associated to the highest degree with the black colour. The phenotypic combinations HbAB/LK and HbBB/HK resemble between them concerning their association with different colours of hair fibres.

So, the association of phenotypes HbAB and HK could contribute, to a great extent, to improving the qualitative morphological and histochemical features of lamb pelts, in exchange the phenotypic association between HbBB and LK seems to have a selective advantage on the other phenotypic combinations in the direction of the diversification and strengthening of the range of colours and of their shades.

The association of haemoglobin types with those of blood potassium should be attributed to the linkage between the loci Hb and K. Due to the existence of this linkage, some correlations can be established between different phenotypic combinations and the qualitative features of the lamb pelts by the influence of the potassium phenotype on the haemoglobin types, especially on the degree of affinity or dissociation of oxygen to the haemoglobin molecule. At the same time, the associative diversity of the phenotypic combinations Hb/K with the production traits would be due to the linkage of the loci Hb and K with the loci of other biochemical genetic systems, such would be glucose-6-phosphate, ceruloplasmin, glutathione, glucose-6-phosphate dehydrogenase or some blood group factors. But, probably, the main factor would be the metabolic profile of red cell in relation to its haemoglobin and potassium phenotypes dictated, it seems, to a great extent, by the phenomena of active cationic transport from the haematic wall level (Yaman *et al*, 1986; Khan, 1987; Moradi Shahrabak *et al*, 2007).

Comparing among them the empirical distributions of qualitative features of the lamb pelts in relation to all phenotypic associations of the haemoglobin and potassium systems, it comes out that among different subpopulations of lambs there are very great and very significant differences, concerning both each feature and all traits, the values of the test χ^2 exceeding the most critical threshold of significance (0.1%) (Tables 1 and 2).

Such studies have not been reported by the speciality literature. Similar studies refer to the association of qualitative features lamb pelts only with a simple biochemical genetic system, either haemoglobin (Hrinca, 1988) or potassium (Hrinca et al., 2000). Correlational analysis of these two biochemical-genetic structures or of the combinations Hb/K with the sheep productivity had in view those with the quantitative production traits (meat, wool, milk) (Lipecka et al., 1984; Yaman et al., 1986, Khan, 1997; Moradi Shahrababak et al., 2007).

Table 1. Testing the differences between haemoglobin/potassium phenotypic combinations concerning the main qualitative features of lamb pelts of Karakul type

Production trait	Phenotypic combination	"t"	Liberty degrees
Curl shape	HbAB/LK – HbAB/HK	41.98***	4
	HbAB/LK – HbBB/LK	67.47***	
	HbAB/LK – HbBB/HK	99.08***	
	HbAB/HK – HbBB/LK	53.95***	
	HbAB/HK – HbBB/HK	70.01***	
Curl size	HbBB/LK – HbBB/HK	175.03***	3
	HbAB/LK – HbAB/HK	41.91***	
	HbAB/LK – HbBB/LK	67.22***	
	HbAB/LK – HbBB/HK	92.51***	
	HbAB/HK – HbBB/LK	53.55***	
Hair fibre quality	HbAB/HK – HbBB/HK	68.45***	3
	HbBB/LK – HbBB/HK	170.25***	
	HbAB/LK – HbAB/HK	41.92***	
	HbAB/LK – HbBB/LK	67.12***	
	HbAB/LK – HbBB/HK	105.34***	
Hair fibre lustre	HbAB/HK – HbBB/LK	53.80***	3
	HbAB/HK – HbBB/HK	68.23***	
	HbBB/LK – HbBB/HK	177.19***	
	HbAB/LK – HbAB/HK	41.95***	
	HbAB/LK – HbBB/LK	66.92***	
Hair fibre colour	HbAB/LK – HbBB/HK	92.48***	2
	HbAB/HK – HbBB/LK	54.22***	
	HbAB/HK – HbBB/HK	70.66***	
	HbBB/LK – HbBB/HK	173.80***	
	HbAB/LK – HbAB/HK	41.96	
	HbAB/LK – HbBB/LK	67.38	
	HbAB/LK – HbBB/HK	95.82	
	HbAB/HK – HbBB/LK	53.71	
	HbAB/HK – HbBB/HK	69.79	
	HbBB/LK – HbBB/HK	174.69	

Table 2. Testing the differences between haemoglobin/potassium phenotypic combinations concerning all qualitative features of lamb pelts of Karakul type

All qualitative features of lamb pelts	Phenotypic combination	χ^2	Liberty degrees
		HbAB/LK – HbAB/HK	41.94***
	HbAB/LK – HbBB/LK	67.22***	
	HbAB/LK – HbBB/HK	97.05***	
	HbAB/HK – HbBB/LK	53.88***	
	HbAB/HK – HbBB/HK	69.434***	
	HbBB/LK – HbBB/HK	174.19***	

Conclusion

In the Botosani Karakul sheep, the associations were established between the four combinations of the haemoglobin and potassium phenotypes existing in this breed, on the one hand, and the main qualitative features of lamb pelts, on the other hand.

The phenotypic combinations HbBB/KH is associated with the most valuable morpho-histochemical features of the lamb pelts (shape and size of curls, quality and lustre of hair fibres), while the phenotypic combination HbBB/LK is associated with the largest range of colours.

The differences among all phenotypic combinations Hb/K, in the terms of qualitative traits of lamb pelts, are very significant, having statistical assurance.

Povezanost fenotipskih kombinacija Hb/K sa osobinama kvaliteta krzna jagnjadi rase Botosani Karakul

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Rezime

Specifičnost proizvodnje ovaca koje pripadaju Botosani Karakul rasi je jagnjeće krzno karakteristično po različitim kvalitativnim osobinama (oblik i veličina pramenova, kvalitet, sjaj i boja vlakana pramenova), koje ovu rasu svrstavaju u plemenite i razlikuju je među drugim rasama. Ovo istraživanje je pokušaj asocijativne analize ovih osobina jagnječeg krzna sa različitim kombinacijama između hemoglobinskih i kalijumskih fenotipova. Najvrednija osobina u pogledu oblika i veličine pramenova kao i kvaliteta i sjaja vlakana u pramenovima povezana je sa kombinacijom fenotipova HbAB i HK, dok je najslabija povezanost ovih osobina utvrđena kod fenotipske kombinacije

HbBB/LK. Sivkaste, braon, sive, roze i bele boje vlakana su više povezane sa fenotipskom kombinacijom HBB/LK, dok je najniža učestalost ovih boja utvrđena kod fenotipa HbAB uz fenotip HK, ali je ova poslednja fenotipska kombinacija u većem stepenu povezana sa pojavom crne boje. Razlike u empirijskim distribucijama kvalitativnih osobina jagnječeg krzna u odnosu na sve fenotipske kombinacije hemoglobinskih i kalijumskih sistema su vrlo značajne, činjenica je kojom se preporučuje korišćenje ova dva biohemijsko-genetička sistema za unapređenje Botosani Karakul rase u proizvodnji jagnječeg krzna.

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