Biotechnology in Animal Husbandry 35 (4), 347-355 , 2019
Publisher: Institute for Animal Husbandry, Belgrade-Zemun
ISSN 1450-9156
UDC 636.32
https://doi.org/10.2298/BAH1904347Z

ESTIMATION OF GROWTH TRAITS HERITABILITY COEFFICIENTS IN SHEEP

Krstina Zeljić[1], Dragan Stanojević[1], Vladan Bogdanović[1], Cvijan Mekić[1], Dragana Ružić-Muslić[2], Nevena Maksimović[2], Nenad Stojiljković[2]

[1]Faculty of Agriculture, University of Belgrade, Nemanjina 6, 11080 Belgrade-Zemun, Serbia.
[2]Institute for Animal Husbandry, Autoput 16, 11080 Belgrade-Zemun, Serbia.
Corresponding author: Krstina Zeljić, krstina.zeljic@yahoo.com
Original scientific paper

Abstract: The objective of this research paper was to estimate heritability coefficients (heritability) of growth traits in the lambs of indigenous Sjenicka Pramenka breed. The research was conducted on a sample which included 421 lambs the descendants of 15 sires and 187 sheep-dams, raised on 3 private farms in Kolubarski district, Serbia. The effect of fixed factors was studied while the values of heritability coefficients were estimated within the frame of SAS software package. A statistically highly significant (**=P<0.01) effect on studied traits had following parameters: sex, year of lambing, type of lambing, farm and method of applied reproductive technology. By means of REML method and using the sire model the values of heritability coefficients were determined for the following traits: average lamb birth weight (BW0), average lamb body weight at 30 days (BW30) and average lamb body weight at 90 days (BW90) being: 0.0355; 0.4642 and 0.3018, respectively.

Key words: lambs, growth, heritability, Sjenicka Pramenka sheep.

Introduction

In total value of agricultural production in 2017. livestock production accounted for 38.3%, the highest rise being recorded in sheep breeding (7.4%) what makes this branch of agriculture very important for our country. Regarding the breed composition the largest part of sheep population is made of indigenous Pramenka sheep breed, in central Europe known as Zackel (*Drăgănescu and Grosu, 2010*), of combined direction of production (meat-milk-wool) within which stock the largest number of animals belong to Sjenica strain. Besides the size of sheep population, sheep fertility (number of lambs in litter, number of lambing per

year), along with nutrition, fattening and lamb slaughter traits (*Senčić et al., 2010*) has an important effect on meat production as well. Production of lamb meat obtained from young lambs up to 90 days old, and of the carcass weight of 10 to 12 kg, i.e. about 25 kg live weight, is a predominant one. By improvement aimed at increasing the production of meat the obtaining of lambs with higher daily weight gain (over 300 g), higher final body weight at 90 days (over 28 kg), as well as higher dressing percentage of more than 58% (*Petrović et al., 2013*) should be rendered possible. On the other hand, by breeding purebred animals a high quality meat is obtained as a result of breeding and nutrition in a preserved and abundant natural environment such as it is in a hilly-mountainous region of our country.

In order that selection be conducted successfully and for the purpose of obtaining higher production of sheep meat it seems necessary to know external factors which quantity and quality of meat (housing, nutrition, care) depend on as well as genetic parameters (heritability, repeatability, genetic correlations) which have an economic effect on production.

Type of birth, lamb sex, year of birth, age and weight of dams statistically significantly affected body weight of Sönmez lambs *(Taskin et al., 2012),* Afshari lambs *(Latifi and Mohammadi, 2018),* and Baluchi lambs *(Abbasi et al., 2012).*

With high values of heritability coefficients known it is possible, on the basis of phenotypic expressiveness, to predict genetic value of an individual what is deemed important in selection programmes. Heritability values are characteristic for a population since genetic variance depends on segregation of alleles which affect the trait, on frequencies of alleles, on the effects and mode of action of genes, as well as on variations of the environment which can be different in different populations *(Visscher et al., 2008).*

The values of heritability coefficient for growth trait ranged from 0.03 (*Perez et al., 2017)* for body weight at birth in Romney Marsh lambs to 0.46 for the same trait in Menz breed as reported by *Gizaw et al. (2007),* while for body weight at weaning heritability value was 0.96 as calculated by *Perez et al. (2017)* for Hampshire breed.

Materials and Methods

Studying phenotypic variability and determining the values of heritability coefficients was conducted on a sample of 421 lambs which were descendants of 15 sires and 187 sheep-dams of Sjenicka Pramenka strain sheep. The animals were raised on 3 private farms in the region of Kolubarski district. Ewe-dams lambed in the period from early 2016. to the end of 2017. Synchronization and induction of oestrous were carried out on farm 1 and farm 2 on 131 animals, while the ewes on farm 3 were mated in season without application of hormones in reproduction. Induction and synchronization of oestrous in ewes was performed by application of

vaginal pessary (60 mg medroxy-progesterone acetate in the course of 12 days + 500 i.j. PMSG). The ewes on all three farms were 4.8 years old on average. A calendar year was divided into 4 seasons (quarters), each season consisting of 3 months: winter (December, January, February), spring (March, April, May), summer (June, July, August) and autumn (September, October, November).

The research included following lamb body weights: an average body weight at birth (BW0), body weight at 30 days (BW30) and body weight at 90 days (BW90=WW) of age, i.e. weight at weaning (weaning weight). Principal statistical parameters of phenotypic expression and variability of studied traits were calculated by means of standard statistical procedures by help of PROC MEANS procedure within SAS programme package (*SAS Inst., Inc., Cary, NC*).

The effect of fixed factors was studied by help of GLM procedure within SAS programme package (*SAS Inst., Inc., Cary, NC*). During research a fixed model was used which incorporated the research of the effect such as follows: dam`s age (12 classes in relation to the age of animals in years), type of lambing (singles and twins), year and season of lambing, lamb sex, farm and an applied method of reproductive technology (induction and synchronization of oestrous outside season and natural mating in season).

An applied fixed model was such as follows:

$Y_{ijklmno} = \mu + F_i + G_j + Z_k + S_l + T_m + P_n + R_o + e_{ijklmno}$

In which:

$Y_{ijklmno}$- is a phenotypic expression of a studied trait

μ- population general average

F_i- fixed effect of i farm (i=1, 2, 3)

G_j- fixed effect of j year of birth (j=2016, 2017)

Z_k- fixed effect of k lambing season (k=1, 2, 3, 4)

S_l- fixed effect of l dam`s age (l=1, 2, 3...12)

T_m- fixed effect of m type of birth (m=1, 2)

P_n- fixed effect of n lamb`s sex (n=1, 2)

R_o- fixed effect of o method of reproductive technology (o=1, 2)

$e_{ijklmno}$- random error.

Variances of studied traits were calculated by means of VARCOMP procedure, REML method by using the ”SAS/STAT“ programme package **(***SAS Inst., Inc., Cary, NC***)**. Following mixed model was used:

$Y_{ijklmnop} = \mu + F_i + G_j + Z_k + S_l + T_m + P_n + R_o + o_p + e_{ijklmnop}$

In which:

$Y_{ijklmnop}$- is a phenotypic expression of a studied trait

μ- population general average

F_i- fixed effect of i farm (i=1, 2, 3)

G_j- fixed effect of j year of birth (j=2016, 2017)

Z_k- fixed effect of k lambing season (k=1, 2, 3, 4)

S_l- fixed effect of l dam`s age (l=1, 2, 3...12)

T_m- fixed effect of m type of birth (m=1, 2)
P_n- fixed effect of n lamb`s sex (n=1, 2)
R_o- fixed effect of o method of reproductive technology (o=1, 2)
o_p- random effect of p sire (p=1, 2, 3...15)
$e_{ijklmnop}$- random error.

Heritability coefficients were calculated by a method of intra-class correlation of sires` half-sibs, i.e. out of sires` variance components:

$$h^2 = \frac{4 * \sigma^2_{IO}}{\sigma^2_{IO} + \sigma^2_{UO}}$$

where
h^2- is a heritability coefficient
σ^2_{IO}- variance between sires
σ^2_{UO}- variance inside sires.

Heritability errors were calculated by means of a standard procedure.

Results and Discussion

Table 1. Average values and variability of studied traits

Traits	n	x̄	SD	Variance	Min	Max	CV(%)
BW0, kg	421	4.26	0.59	0.35	2.95	5.50	13.83
BW30, kg	421	12.76	1.32	1.75	10.00	15.80	10.35
BW90, kg	419	30.19	2.22	4.95	25.00	36.00	7.37

*BW0= birth weight; BW30= body weight at 30 days; BW90= body weight at 90 days.

An average lamb body weights at birth, at 30 days and at 90 days were 4.26 kg, 12.76 kg, and 30.19 kg, respectively (tab. 1). Calculated average values are much higher in relation to those calculated by *Vujić (1997)* in the same Pramenka strain where in the average body weights of lambs at birth, at 30 days, and at 90 days were 3.81 kg, 9.43 kg, and 22.13 kg, respectively. Higher body weight can be a consequence of the application of selection in Sjenicka Pramenka population as well as of modern technological solutions which improved the conditions of raising. *Petrović et al. (2009)* point out that lamb`s weight at birth plays an important role in accomplishing profitable production since not only live weight gain but also lamb`s vitality and mortality depend on the initial body weight.

Table 2 shows the levels of significance of the influence of the effects included in the model on studied lamb growth traits in Sjenicka Pramenka sheep.

Table 2. Values of F- test for studied factors

Traits	Factors							
	Dam`s age (year)	Lambing season	Lambing year	Lambing type	Sex	Farm	Method of reproductive technology	R^2
BW0	1.43^{ns}	1.22^{ns}	15.91^{**}	493.58^{**}	2.44^{ns}	55.13^{**}	96.67^{**}	0.89
BW30	0.26^{ns}	0.44^{ns}	3.87^{*}	115.25^{**}	5.97^{*}	6.15^{*}	8.52^{**}	0.94
BW90	5.47^{*}	0.66^{ns}	129.88^{**}	252.32^{**}	21.09^{**}	0.88^{ns}	1.57^{ns}	0.97

^{nz}=P>0.05; *=P<0.05; **=P<0.01; R^2= coefficient of determination.

Factors such as: sex, lambing year, lambing type, farm and method of applied reproductive technology had a statistically highly significant (**=P<0.01) effect on the traits. Lambing season did not statistically significantly affect studied traits because a larger number of ewes (70.1%) in the research underwent hormonal treatment, that is, synchronization of oestrous, so ewes lambed through out a whole year. Determination coefficients (R^2) show that by the effects included in the model, 0.89% to 0.97% of variability of studied growth traits can be explained.

Boujenane and Diallo (2016) came to the conclusion that dam`s age, type of birth, lamb`s sex and year of birth statistically significantly affected body weight at birth, at 30 days and at weaning in Sardi sheep. *Mekić et al. (2008)* reported results of development of Sjenicka Pramenka lambs from birth to the age of 90 days depending on the farm effect, sex and type of birth. According to the applied linear model general average for body weight at birth was 3.52 kg, at 30 days 8.72 kg and at 90 days 20-56 kg. A farm and birth type had a significant effect on studied lamb traits.

Table 3. Values of heritability (h^2) and standard errors of heritability (S_h^2) for growth traits in Sjenicka pramenka breed sheep

Traits	n	h^2	S_h^2
BW0	421	0.0355	0.0132
BW30		0.4642	0.1124
BW90	419	0.3018	0.0791

The growth traits in Sjenicka Pramenka lambs have low (0.0355 for body weight at birth), medium (0.3018 for lamb`s body weight at 90 days) and high values of heritability (0.4642 for body weight at 30 days).

Determined heritability values for body weight at birth are consistent with the values reported by *Perez et al. (2017)* in Katahdin breed (0.07±0.0015), *Boujenane and Diallo (2016)* in Sardi sheep (0.07±0.02), *Ozcan et al. (2005)* in Turkish Merino sheep (0.08), *Kastelic and Kompan (2007)* in lambs of Jezersko-

solcavska breed (0.078±0.035) and with *Haile et al. (2018)* who determined low heritability values during mating between Syrian and Turkish Avasi sheep (0.03±0.022 and 0.06±0.042). Medium heritability values for this trait were determined by *Baneh and Ahmadpanah (2018)* for local Iranian Ghezel breed (0.285) and by *Murphy et al. (2018)* 0.27 in crossbreds obtained by crossing the sheep dairy breed (Eastern-Friesian and Lacaune breed). Heritability value calculated for body weight at weaning corresponds to the values reported by *Zishiri et al. (2014)* for Dormer breed (0.28±0.02) and Merino landsheep (0.25±0.05), while it is higher than values obtained for Ile de France breed (0.14±0.04).

On the other hand, following authors determined higher heritability values for body weight at birth than at weaning: *Mirhoseini et al. (2015)* in Karakul sheep (0.21 and 0.10); *Miraei-Ashitani et al. (2007)* in Sangsari fat-tailed sheep (0.33±0.05 and 0.17±0.05), *Latifi and Mohammadi (2018)* and *Ghafouri-Kesbi and Eskandarinasab (2018)* in Iranian Afshari breed (0.11 and 0.08; 0.15 and 0.06).

Determined coefficient values and standard error of heritability differ considerably between some authors what can be a consequence of research conducted in different populations, breeds, types of sheep (different size and structure of samples), different conditions of keeping as well as various applied models for calculating heritability. In addition, migration, selection and inbreeding can change the value of this coefficient.

Conclusion

Low and medium heritability values for growth traits in lambs of Sjenicka Pramenka sheep show that by selection performed on the basis of performance and other conventional methods of selection the individuals with best genetic properties can be more difficult to identify what slows down genetic improvement, therefore the selection should be based on the estimation of animal breeding value. Moreover, in the next period the attention should be devoted to genetic markers and MAS selection (Marker Assisted Selection) when choosing the parents of future generations in order to obtain lambs with superior growth traits.

Procena koeficijenta naslednosti za osobine porasta kod ovaca

Krstina Zeljić, Dragan Stanojević, Vladan Bogdanović, Cvijan Mekić, Dragana Ružić-Muslić, Nevena Maksimović, Nenad Stojiljković

Rezime

Cilj rada bio je da se procene koeficijenti naslednosti (heritabilitet) osobina porasta kod jagnjadi sjeničke pramenke. Istraživanje je sprovedeno na uzorku od 421 jagnjadi, potomaka 15 očeva i 187 ovaca-majki sa 3 privatne farme u Kolubarskom okrugu.

Ispitan je uticaj fiksnih faktora i procenjene su vrednosti koeficijenata naslednosti u okviru SAS softverskog paketa. Visoko statistički značajan (**=P<0,01) uticaj na ispitivane osobine imali su: pol, godina jagnjenja, tip jagnjenja, farma i metod primenjene reproduktivne tehnologije.

Metodom intraklasne korelacije polusrodnika po ocu utvrđene su vrednosti koeficijenta naslednosti za osobine: prosečna telesna masa jagnjadi na rođenju (BW0), prosečna telesna masa jagnjadi sa 30 dana starosti (BW30) i prosečna telesna masa jagnjadi sa 90 dana starosti (BW90) i iznosile su: 0,0355; 0,4642 i 0,3018, respektivno.

Ključne reči: jagnjad, porast, heritabilitet, sjenička pramenka.

Acknowledgment

This research was funded by the Ministry of Education, Science and Technological Development, Republic of Serbia, project TR-31086.

References

ABBASI M.A., ABDOLLAHI-ARPANAHI R., MAGHSOUDI A., VAEZ TORSHIZI R., NEJATI-JAVAREMI A. (2012): Evaluation of models for estimation of genetic parameters and maternal effects for early growth traits of Iranian Baluchi sheep. Small Ruminant Research, 104: 62-69.

BANEH H., AHMADPANAH J. (2018): Genetic evaluation of body weight traits in Iranian native Ghezel sheep. Genetika, 50 (1): 275-284.

BOUJENANE I., DIALLO I.T. (2016): Estimates of genetic parameters and genetic trends for pre-weaning growth traits in Sardi sheep. Small Ruminant Research, 146: 61–68.

DRAGANESCU C., GROSU H. (2010): Valachian (Zackel) heritage philetic sheep group- a taxonomic problem. Romanian Academy, DAGENE 1–7.

GHAFOURI-KESBI F., ESKANDARINASAB M. (2018): Heritability of relative growth rate and its relationship with growth-related traits in Afshari sheep. Gene Reports, 12: 225–229.

GIZAW S., LEMMA S., KOMEN H., VAN ARENDONK A.M.J. (2007): Estimates of genetic parameters and genetic trends for liveweight and fleece traits in Menz sheep. Small Ruminant Research, 70: 145–153.
HAILE A., HILALI M., HASSEN H., LOBO R. N. B., RISCHKOWSKY B. (2018): Estimates of genetic parameters and genetic trends for growth, reproduction, milk production and milk composition traits of Awassi sheep. The Animal Consortium, 240-247.
KASTELIC M., KOMPAN D. (2007): Phenotypic and genetic parameters for fertility and growth rate in Slovenian autochthonous sheep breed jezersko-solčavska. Biotechnology in Animal Husbandry, 23 (5-6): 331 - 338.
LATIFI M., MOHAMMADI A. (2018): Analysis of genetic parameters and genetic trends for early growth traits in Iranian Afshari sheep. Biotechnology in Animal Husbandry, 34 (3): 289-301.
MEKIĆ C., TRIFUNOVIĆ G., PERIŠIĆ P., VUJIĆ R., PETROVIĆ M.P. (2008): Uticaj farme, pola i tipa rođenja na telesnu masu jagnjadi za vreme dojnog perioda. Biotechnology in Animal Husbandry, 24: 137-142.
MIRAEI-ASHTIANI R., SEYEDALIAN A., SHAHRBABAK M. (2007): Variance components and heritabilities for body weight traits in Sangsari sheep, using univariate and multivariate animal models. Small Ruminant Research, 73: 109–114.
MIRHOSEINI S.Z., ZARE J., HOSSEIN-ZADEH N.G., KHANZADEH H., SEIDAVI A., LAUDADIO V., DARIO C., TUFARELLIV., SELVAGGI M. (2015): Estimation of genetic parameters for body weight traits and pelt quality score in Iranian Karakul sheep. Small Ruminant Research, 132: 67–71.
MURPHY T.W., BERGER Y.M., HOLMAN P.W., BALDIN M., BURGETT R.L., THOMAS D.L. (2018): Genetic and non-genetic factors influencing the live weight of artificially reared lambs. Small Ruminant Research, 165: 62–65.
OZCAN M., EKIZ B., YILMAZ A., CEYHAN A. (2005): Genetic parameter estimates for lamb growth traits and greasy fleece weight at first shearing in Turkish Merino sheep. Small Ruminant Research, 56: 215–222.
PEREZ J.O., ALDANA T., TORRES D., GRAJALES H., MANRIQUE C. (2017): Estimación de parámetros genéticos de cuatro tipos raciales ovinos del trópico colombiano. Universidad Nacional de Colombia, Facultad de Medicina Veterinaria y Zootecnia, Departamento de Producción Animal Bogotá, Colombia.
PETROVIĆ M. P., RUŽIĆ MUSLIĆ D., MAKSIMOVIĆ N. (2009): Evaluation Of Genetic Potential Of Sheep In Different Production Systems. Biotechnology in Animal Husbandry, 25(5-6-1): 421-429.
PETROVIĆ M.M., ALEKSIĆ S., PETROVIĆ M.P., PETROVIĆ M., PANTELIĆ V., NOVAKOVIĆ Ž., RUŽIĆ-MUSLIĆ D. (2013): Potentials of Serbian livestock production- outlook and future. Biotechnology in Animal Husbandry, 29 (1): 1-17.
SENČIĆ Đ., ANTUNOVIĆ Z., KRALIK D., MILJIĆ P., ŠPERANDA M., ZMAIĆ K., ANTUNOVIĆ B., STEINER Z., SAMAC D., ĐIDARA M., NOVOSELEC J.

(2010): Proizvodnja mesa. Poljoprivredni fakultet, Sveučilište J.J. Strossmayera, Osijek.
TASKIN T., KAYMAKCI M., SONMEZ R., YILMAZ M., BARDAKCIOGLU E.H. (2012): Genetic and non-genetic parameter estimates for growth traits of Sönmez lambs. Veterinarija ir Zootechnika, 60:82.
VISSCHER P.M., HILL W.G., WRAY N.R. (2008): Heritability in the genomics era- concepts and misconceptions. Nature Reviews Genetics, 9(4): 255-266.
VUJIĆ R. (1997): Reproduktivne i proizvodne osobine sjeničkog soja pramenke. Doktorska disertacija, Poljoprivredni fakultet Zemun- Beograd.
ZISHIRI O.T., CLOETE S.W.P., OLIVIER J.J., DZAMA K. (2014): Genetic parameters for live weight traits in South African terminal sire sheep breeds. Small Ruminant Research, 116: 118–125.

Received 27 November 2019; accepted for publication 17 December 2019