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# ANALYSIS OF GENOTYPE, DAM'S LITTER SIZE AND THEIR INTERACTION ON SELECTED PRODUCTIVE TRAITS OF ORIGIN WALLACHIAN AND SUMAVA SHEEP IN THE CZECH REPUBLIC

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## Abstract

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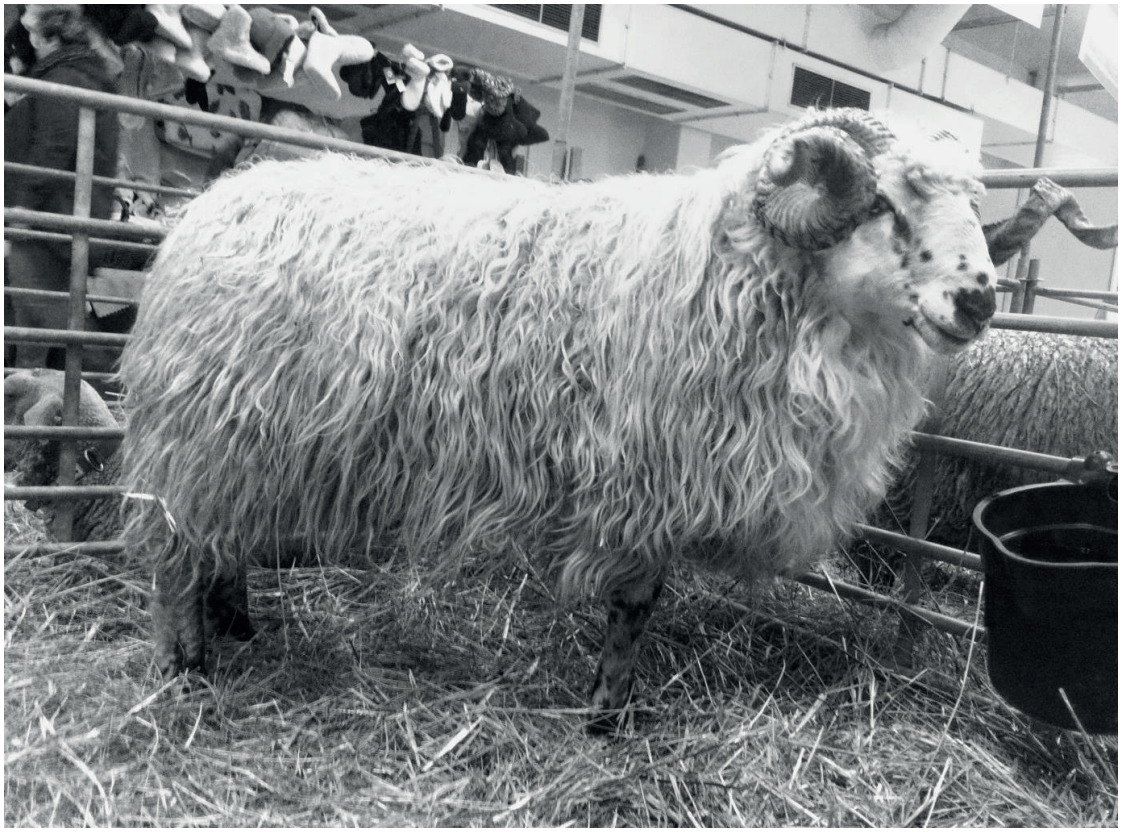
The objective of the study was to evaluate interaction effect of genotype and dam's litter size on selected productive traits of origin Czech sheep breeds. The data was provided by the Union of Sheep and Goat Breeders in the Czech Republic and contained the whole active purebred population of Wallachian and Sumava sheep in the Czech Republic in 2015. Selected productive traits with affiliation to ewes 'reproductive and lambs' growth performance were analyzed. Statistical evaluation of was conducted using SAS 9.3. (SAS/STAT® 9.3., 2011), GLM procedure. No significant differences were detected among Wallachian sheep regardless theirs litter size. Significantly lower total number of lambs born (–0.26 to –0.30 lamb) or reared at 14 days (–0.15 to –0.21 lamb) and 100 days (–0.24 to –0.27 lamb) of age per ewe per lambing were observed in groups of Sumava sheep born as singles and twins in comparison to triplets and quadruplets group. Similarly, Sumava sheep of single and twins reached significantly lower total number of lambs born (–0.23 to –0.34 lamb) or reared at 14 days (–0.22 to –0.33 lamb) and 100 days (–0.28 to –0.41 lamb) of age per ewe per lambing to Wallachian sheep regardless their dam's litter size. No significant decrease of group of Sumava sheep born as triplets and quadruplets was detected in comparison to Wallachian sheep. Moreover, higher (+2.6 kg, $P < 0.05$) total live weight of lambs at 100 days of age from total number of lambs reared at 100 days of age per ewe was detected in group of Sumava born as triplets and quadruplets in comparison to group of Wallachian sheep born as twins. Both sheep breeds are useable in the crossing with other sheep breeds in specified conditions. Results of presented study suggested also potential aim breeding process in Sumava sheep.

Keywords: parity, litter size, live weight, lamb, genetic resource

## INTRODUCTION

Wallachain sheep is an origin sheep with triple (milk, meat, wool) yield purpose (Horák, Treznerová, 2010). Its history dates back to 15th and 16th century when Wallachian sheep reached the area of Beskydy Mountains during Wallachian colonization of Carpathians (Milerski, 2013a). The sheep has medium body size and lower performance parameters. Generally, the rams and most of ewes have horns of a helical form, see Fig. 1. The wool is mixed with long coarse hairs and short kemps (Jandurová *et al.*, 2005). The number of Wallachian sheep was 788 ewes in 2014 in the Czech Republic according to official statistics (Bucek *et al.*, 2015). Sumava sheep was create to breed of Bohemian Land. The regeneration process of Sumava sheep started from 1953 with using Tsigai, Cheviot, Kent, East-Friesian or Texel sheep (Milerski, 2013b). In 1986 Sumava sheep were certified as independent sheep breed (Horák, Treznerová, 2010). It is a dual purpose (wool-meat) sheep with typical shiny



1: *Wallachian sheep (mature breeding ram)*
(Ptáček, 2015)

semi-coarse fleece that overgrows to the head and legs as demonstrated in Fig. 2 (Jandurová *et al.*, 2005; Milerski, 2013b). Sumava sheep is medium body sized breed, adapted to walking and with very good ability to utilize vegetation of less quality within the extended grazing period. For these reasons, this breed plays a crucial role in environmental system of Sumava National Park (Jandurová *et al.*, 2005). The number of Sumava sheep was 2,556 ewes in 2014 in the Czech Republic according to official statistics (Bucek *et al.*, 2015).

Both sheep breeds are characterized by adaptability, resistance to harsh climatic conditions and by its suitability of extensive management systems in submontane and montane regions (Jandurová *et al.*, 2005; Milerksi, 2013a,b). Wallachian sheep were classified among genetic resources of the Czech Republic from 1999 as well as Sumava sheep in 1992. Both these breeds are also resources of specific genes which are usable for breeding other sheep breeds (Milerski, 2013a, b).

Analysis of basic productive traits is important from the viewpoint of their crossbreeding with specific meat purpose breeds or potential aiming of breeding process these breeds. Productive traits are reflected by ewes' reproductive traits as well as growth performance traits of their lambs. Monitoring of productive traits performed on local rustic sheep in specific breeding conditions is very frequently published. As example Abdel-Mageed, Abo El-Maaty (2012) as well as Vatankhah *et al.* (2012) described basic productive traits in Rahmani, Barki, Ossimi or Lori-Bakhtiari sheep. However, no information about productive performance of origin Czech sheep breeds has been published yet.

Some previous studies concerned milk production or milk composition compound of Improved Wallachian sheep (Oravcová *et al.*, 2007; Tančin *et al.*, 2011; Mačuhová *et al.*, 2012) in the Slovak Republic. Their results indicated that origin Slovak sheep genotype is usable for milk production. Further, also results of growth abilities of Improved Wallachian crossbreds with different East Friesian or Suffolk bloodshare were published by Kuchtík, Dobeš (2006) or Dobeš *et al.*, (2007). Their results documented only minor influence of different Suffolk or East Friesian bloodshare on growth abilities of Improved Wallachian lambs crossbreds.

The aim of presented study was to analyze basic productive traits of origin Wallachian and Sumava sheep population in the Czech Republic with regard to genotype, dam's litter size and their interaction.

2: *Sumava sheep (mature breeding ram)*
(Ptáček, 2015)

## MATERIALS AND METHODS

### Data collection and evaluated traits

The study was performed on the whole of active purebred population of Wallachian (W100) and Sumava (S100) sheep in the Czech Republic in 2015. The data was provided by the Union of Sheep and Goat Breeders in the Czech Republic (SCHOK, 2016). The results were presented with factors of genotype (2 classes: W100, S100), dam's litter size (3 classes: singles, twins, triplets and quadruplets) and their interaction (6 classes) as criteria.

The following productive traits (Abdel-Mageed, Abo El-Maaty, 2012; Vatankhah *et al.*, 2012) were created from the officially published data:

- total number of lambs born per ewe per lambing (LBL; lambs)
- total number of lambs reared at age of 14 days per ewe per lambing (LR14; lambs)
- total number of lambs reared at age of 100 days per ewe per lambing (LR100; lambs)
- total number of lambs reared at 100 days of age from total number of lambs born per ewe (LR100/LB; lambs)
- total live weight of lambs at 100 days of age per ewe per lambing (TLW100; kg)
- total live weight of lambs at 100 days of age from total number of lambs reared at 100 days of age per ewe (TLW100/LR100; kg)

### Statistical analysis

All statistical analyses were conducted using SAS 9.3. (SAS/STAT® 9.3., 2011), MEANS and GLM procedures. The REG procedure under the STEPWISE method was used for appropriate model selection. Each model contained the fixed effects of genotype (W100, n = 736; S100, n = 2001), dam's litter size (singles, n = 1455; twins, n = 1202; triplets and quadruplets, n = 80), classification of ewes' genetic predisposition (elite record class, n = 692; elite class, n = 975; first class, n = 659; second class, n = 411) and two-way (genotype × dam's litter size) interaction. Factors of flock (1–81) and dam's age (2 to 14) were evaluated as covariates.

The differences between the variables estimated were tested by the Tukey-Kramer method at the level of significance $P < 0.05$.

I: *Basic characteristics of dataset structure*

| Variable | N | AM | Sd | Min. | Max. | CV |
|---|---|---|---|---|---|---|
| **LBL** | 2737 | 1.22 | 0.37 | 0.25 | 3 | 31.63 |
| **LR14** | 2737 | 1.12 | 0.38 | 0.20 | 3 | 34.31 |
| **LR100** | 2737 | 0.96 | 0.42 | 0.13 | 3 | 44.80 |
| **LR100/LB** | 2737 | 0.78 | 0.24 | 0.13 | 1.33 | 31.19 |
| **TLW100** | 2737 | 21.4 | 9.99 | 2.7 | 75.8 | 46.68 |
| **TLW100/LR100** | 2737 | 23.0 | 4.78 | 6.4 | 94.4 | 20.83 |

N = number of observing; AM = arithmetic mean; Sd = standard deviation; Min. = minimal value; Max. = maximal value; CV = coefficient of variance ( %); LBL = total number of lambs born per ewe per lambing (lambs); LR14 = total number of lambs reared at age of 14 days per ewe per lambing (lambs); LR100 = total number of lambs reared at age of 100 days per ewe per lambing (lambs); LR100/LB = total number of lambs reared at 100 days of age from total number of lambs born per ewe (lambs); TLW100 = total live weight of lambs at 100 days of age per ewe per lambing (kg); TLW100/LR100 = total live weight of lambs at 100 days of age from total number of lambs reared at 100 days of age per ewe (kg)

II: *Effect of genotype, dam's litter size and their interaction on selected productive traits of Wallachian and Sumava sheep*

| | LBL | LR14 | LR100 | LR100/LB | TLW100 | TLW100/ LR100 |
|---|---|---|---|---|---|---|
| **Genotype** | | | | | | |
| W100 | $1.45^{A}$ | $1.33^{A}$ | $1.23^{A}$ | $0.86^{A}$ | $26.6^{A}$ | $21.8^{A}$ |
| S100 | $1.17^{B}$ | $1.07^{B}$ | $0.88^{B}$ | $0.76^{B}$ | $20.5^{B}$ | $23.2^{B}$ |
| **Dam's litter size** | | | | | | |
| Singles | $1.25^{A}$ | $1.14^{A}$ | $1.00^{A}$ | 0.81 | $21.9^{A}$ | 22.3 |
| Twin | $1.29^{B}$ | $1.19^{A}$ | $1.04^{B}$ | 0.81 | $23.0^{B}$ | 22.5 |
| Triplets and quadruplets | $1.39^{C}$ | $1.27^{B}$ | $1.12^{B}$ | 0.81 | $25.8^{C}$ | 22.7 |
| **Genotype × dam's litter size** | | | | | | |
| W100 × singles | $1.39^{A}$ | $1.27^{A}$ | $1.17^{A}$ | $0.86^{A}$ | $25.5^{A}$ | $22.0^{AB}$ |
| W100 × twins | $1.45^{A}$ | $1.34^{A}$ | $1.24^{A}$ | $0.86^{A}$ | $26.2^{A}$ | $21.5^{A}$ |
| W100 × triplets and quadruplets | $1.38^{A}$ | $1.28^{A}$ | $1.14^{A}$ | 0.84 | $24.5^{A}$ | 21.4 |
| S100 × singles | $1.11^{B}$ | $1.01^{B}$ | $0.83^{B}$ | $0.75^{B}$ | $18.7^{B}$ | $22.8^{BC}$ |
| S100 × twins | $1.15^{B}$ | $1.05^{B}$ | $0.86^{B}$ | $0.76^{B}$ | $19.9^{C}$ | $23.3^{C}$ |
| S100 × triplets and quadruplets | $1.41^{A}$ | $1.26^{A}$ | $1.10^{A}$ | 0.78 | $27.3^{A}$ | $24.1^{BC}$ |
| **Significance** | | | | | | |
| Flock | *** | *** | *** | *** | *** | * |
| Dam's age | *** | * | *** | *** | * | *** |
| Class of total breeding value | *** | *** | *** | *** | *** | *** |
| Genotype | *** | *** | *** | *** | *** | *** |
| Dam's litter size | *** | *** | *** | n.s. | *** | n.s. |
| Genotype × dam's litter size | *** | *** | *** | *** | *** | *** |

W100 = purebred Wallachian sheep; S100 = purebred Sumava sheep; LBL = total number of lambs born per ewe per lambing (lambs); LR14 = total number of lambs reared at age of 14 days per ewe per lambing (lambs); LR100 total number of lambs reared at age of 100 days per ewe per lambing (lambs); LR100/LB = total number of lambs reared at 100 days of age from total number of lambs born per ewe (lambs); TLW100 = total live weight of lambs at 100 days of age per ewe per lambing (kg); TLW100/LR100 = total live weight of lambs at 100 days of age from total number of lambs reared at 100 days of age per ewe (kg); Means within columns with different letters differed significantly (A,B,C = $P < 0.05$); n.s. = non-significant factor; * = significant factor on $P < 0.05$; ** = significant factor on $P < 0.01$; *** = significant factor on $P < 0.001$

## RESULTS

### *Basic statistics and model description*

In addition to the database characteristic, arithmetic means, standard deviations, minimum and maximum values and variation coefficients are presented in Tab. I.

Model used to explain the variation in productive traits of Wallachian and Sumava sheep was significant ($P < 0.01$). Particular values of $R^2$ ranged from 0.110 (TLW100/LR100) to 0.248 (LBL). All the factors in model were significant, except of dam's litter on LR100/LB and dam's litter size on TLW100/LR100 traits. Significance of partial factors in model used is presented in Tab. II for the better view.

***Genotype and dams' litter size differences***

The results of genotype differences are presented in Tab. II. Wallachian sheep showed significantly higher LBL (+0.28 lamb), LR14 (+0.26 lamb), LR100 (+0.35 lamb), LR100/LB (+0.10 lamb), and TLW100 (+6.1 kg) traits. Contrary, higher TLW100/LR100 (+1.4 kg; $P < 0.05$) was detected in Sumava sheep.

Generally, the highest values were marked in dams of highest litter size (group of triplets and quadruplets) indicating, that these mothers had good maternal abilities to rear more numerous litters. More specifically, group of sheep born as triplets and quadruplets significantly differed to singles and twins groups in LBL (0.10 to 0.14 lamb), LR14 (0.08 to 0.13 lamb), LR100 (0.08 to 0.12 lamb) and TLW100 (2.8 to 3.9 kg) attributes.

### *Genotype and dams' litter size interaction*

Interesting results were obvious from genotype × dam's litter size interaction. The productive traits among Wallachian sheep of different dam's litter size did not significantly differ. However, there was a decreased tendency with increasing dam's litter size in Wallachian sheep, such that numerically lowest values of all the traits were detected in group of dam's born as triplets and quadruplets. Oppositely, group of Sumava sheep born as of triplets and quadruplets reached significantly higher LBL (+0.26 to 0.30 lamb), LR14 (+0.15 to 0.21 lamb), LR100 (+0.24 to 0.27 lamb) and TLW100 (+7.4 to 8.6 kg) traits in comparison with Sumava sheep of singles or twins groups. Significantly lowest values reaching up to 0.34lamb in LBL, 0.33 lamb in LR14 and 0.41lamb in LR100 parameters were detected among Sumava dam's born as singles in comparison with Wallachian sheep of twins. Also significantly higher LR100/LB or TLW100 traits were observed in Wallachian dams of singles and twins in comparison with groups of Sumava dam's born as singles and twins. As important no significant decrease of productive traits was detected in group of Sumava triplets and quadruplets in comparison with Wallachian sheep regardless their dam's litter size. Moreover, the highest TLW100/LR100 trait was detected in group of Sumava triplets and quadruplets, which significantly differed to Wallachian sheep born as twins (+3.4 kg).

## DISCUSSION

Wallachian and Sumava sheep population is spreading (Bucek *et al.*, 2015). This process is supported by National Government subsidies, compensating lack of yield in comparison to specified meat or milk purpose sheep breeds. This fact could be reflected in situation that practically 39 % of all animals were genetically below-average (2 worst classes according to their breeding values estimation).

Wallachian and Sumava sheep are bred in specified regions of the Czech Republic; therefore, there is only limited possibility of relevant discussion with other studies. Nevertheless, Abdel-Mageed, Abo El-Maaty (2012) described productive traits in 3 local rustic breeds (Rahmani, Barki, Ossimi sheep) in Egypt. Their results clearly indicated lower values of productive traits in comparison with Czech sheep genetic resources. Growth intensity of Improved Wallachian × East Friesian (Kuchtík and Dobeš, 2006) or Improved Wallachian x Suffolk (Dobeš *et al.*, 2007) crossbreds at 70 or 100 days of age was also monitored in breeding conditions of the Czech Republic. Their results confirmed only minor influence of East Friesian or Suffolk blood share variations on growth performance traits of Improved Wallachian crossbreds. Nevertheless, Improved Wallachian × East Friesian crossbreds reached higher lambs growth intensity at 100 days of age (Dobeš *et al.*, 2007) in comparison to Wallachian or Sumava sheep in presented study. The difference published by study of Dobeš *et al.* (2007) was compared with TLW100/LR100 attribute in our study, which directly reflected the growth abilities of Wallachian and Sumava lambs.

As expected, higher values of lambs growth abilities were monitored in Suffolk, Charollais, Texel or Kent purebred populations (Štolc *et al.*, 2011; Ptáček *et al.*, 2013; Ptáček *et al.*, 2015), indicating, that all these breeds should be used in sire position while potential crossing.

Generally, Wallachian sheep showed higher productive performance. Nevertheless, interesting results were detected in interaction evaluation, where group of Sumava sheep born as triplets and quadruplets did not significantly decrease in their productive traits in comparison with Wallachian sheep regardless litter size. Moreover, Sumava sheep showed to have greater potential in lambs growth intensity (expressed by TLW100/LR100 attribute), which was manifested in fixed effect of genotype as well as interaction evaluation. Sumava sheep born as triplets or quadruplets reached significantly lower live weight at 100 days of age in comparison to singles (Ptáček, unpublished data). This is one of potential reasons that they were less selected into the reproduction. Nevertheless, results of presented

study indicated, that Sumava dams born as triplets or quadruplets could reach higher productive traits, despite the reason they lagged behind their contemporaries in growth abilities at 100 days of age. Sumava sheep population was represented by more than 3 times higher number of animals in comparison to Wallachian sheep. Therefore, there is the broader scope of the possible selection in Sumava sheep population. The results of presented study indicated, that litter size in Sumava sheep could be one of potential aim of breeding for improving the productive traits.

The obtained results also confirmed the possibility of crossing Wallachian or Sumava sheep with prolific breeds as Romanov or Merinolandschaf sheep (Schmidová *et al.*, 2014) to produce resistant and productive sheep in maternal position. Relatively low losses during the rearing of numerous litters indicated that these sheep breeds are able to rear more numerous lambs with no difficulty.

## CONCLUSION

Results of presented study documented, that Wallachian sheep had higher productive traits with affiliation to reproductive performance, while Sumava sheep reached higher productive attribute directly reflecting lambs' growth abilities. Generally, Wallachian sheep showed balanced productive traits regardless dam's litter size. Contrary, group of Sumava sheep born as triplets and quadruplets overreached Sumava sheep of singles and twins groups. As important no significant decrease of productive traits was demonstrated among Sumava sheep coming from triplets and quadruplets group in comparison to Wallachian sheep regardless dam's litter size. Anyway, both these sheep breed should be used in crossing with meat purpose breeds to improve meat performance of sheep kept in specific regions of the Czech Republic. Rearing abilities of Wallachian and Sumava sheep also indicated possibility of mating these breeds with profile sheep breeds to increase reproductive traits in the flock.

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