26th international DAGENE SYMPOSIUM 2015
17th – 19th June, 2015
Hotel Vita, Terme DOBRNA,
DOBRNA, SLOVENIA

PROCEEDINGS

SYMPOSIUM PROGRAMME

	June 17th, 2015	
17.00-19.00	Registration of participants	
	June 18th, 2015	
8.00-9.00	Registration of participants	
9.00-9.15	OPENING CEREMONY	
9.15-10.55	***Session 1: Phenotypic and genetic traits of local breeds*** ***Chairman: Beate Berger***	
9.15-9.35	Kata Annus:	Characterisation of the maternal lineages in Hungarian Tsigai variants based on the mitochondrial DNA sequences
9.35-9.55	Danijela Bojkovski:	Morphological characterisation of native Bela Krajina Pramenka sheep
9.55-10.15	Ljuba Štrbac:	Phenotypic and genetic variability of some morphological traits of Nonius horse in Serbia
10.15-10.35	Špela Malovrh:	Growth of Krškopolje pig in different environments
10.35-10.55	Janja Urankar:	Fertility in Krškopolje sows
10.55-11.20	COFFEE BREAK	
11.20-13.00	***Session 2: The quality of products of local breeds*** ***Chairman: Ante Ivanković***	
11.20-11.40	Metka Žan Lotrič:	Historical Overview of Slovenian Autochthonous Cika Cattle Breed Production Traits - Milk Yield
11.40-12.00	Beate Berger:	The Krainer Steinschaf - an old breed and a new chance
12.00-12.20	Zsolt Becskei:	Meat quality of autochthonous Sjenica Zackel sheep - Basis for sustainable production of genetic resource on the Sjenica-Pester plateau
12.20-12.40	János Seregi:	Data about the Hungarian indigenous breed, examination of Racka sheep meat
12.40-13.00	Mojca Pestotnik:	Production traits of hens, physical characteristics of eggs and cholesterol content in eggs from the Slovenian traditional egg laying chicken breeds
13.00-14.30	LUNCH BREAK	

	June 18th, 2015	
14.30-16.10	***Session 3: Free communication program*** ***Chairman: Andras Gaspardy***	
14.30-14.50	Tina Flisar:	Genetic profile of Krškopolje pig based on microsatellite markers
14.50-15.10	Pero Mijić:	Breeding of Slavonian Syrmian Podolian on Gajna grassland and its role in preservation of tradition and biodiversity
15.10-15.30	Enikő Somogyvári:	Evaluation of Hucul horse strains
15.30-15.50	Ante Ivanković:	Busha cattle documentary
15.50-16.10	Daša Jevšinek Skok:	Mobile application for twelve Slovenian autochthonous breeds
16.10-16.30	FINAL CONCLUSIONS	
16.30-17.00	COFFEE BREAK	
17.15-18.15	ANNUAL ASSEMBLY OF DAGENE	
20.00	SOCIAL DINNER	
	June 19th, 2015	
8.30-13.00	STUDY EXCURSION – farm with Slovenian autochthonous breeds	

Contents

Phenotypic and genetic traits of local breeds

Characterisation of the maternal lineages in Hungarian Tsigai variants based on the mitochondrial DNA sequences

Kata Annus, Katalin Pásztor, Edina Vada, András Gáspárdy

Szent István University, Faculty of Veterinary Science, Institute for Animal Breeding, Nutrition and Laboratory Animal Science, Department of Animal Breeding and Genetics, István u. 2. HU-1078, Budapest, Hungary

ABSTRACT

The maintenance of a greater genetic diversity is essential on the course of preservation of our old, rare domestic animal breeds. We are the first to analyse the genetic background by the use of mitochondrial DNA (mtDNA) sequence in the Hungarian native Tsigai breed, and compare it to the sequences of GenBank. The investigation was carried out in order to serve data for a within family selection. The DNA samples were taken from the descendants of the eldest families based on herd booking (and from two more breed variants, altogether from 81 individuals) in 2014. The control region of mtDNA showed nucleotide deviation at 98 sites. However, the differences among the individuals were limited to few loci; so the maternal genetic background of the Tsigai breed seems to be unified. The genetic information confirmed the origin of the families/flocks known from the breed history. Ninety-four percent of the samples belonged to the ovine haplogroup B (in 42 cases with full matches with the reference of GenBank, DQ852175.1). This fact proves the significant European maternal origin of the Hungarian Tsigai. A more intense focusing on the maternal side is motivated also by that the females are present at greater number than the males, they remain in breeding for a longer period of time respectively, so they can be the depositaries of realization and maintenance of genetic diversity at larger extent.

Keywords: sheep, mtDNA, haplogroup, Tsigai, breed preservation

INTRODUCTION

The ancient Tsigai was not a primitive breed, but a highly developed multipurpose one. During the 18th and 19th centuries, the golden age of the breed, it was unrivalled at the three primary uses of these sheep: as a source of finer wool, milk and mutton. The Tsigai arrived at Hungary by means of its finer wool quality than the other contemporary home sheep breeds at that time. During the last 200 years, the Tsigai were continuously present in Hungary but in varying proportion (1% – 10%) to other breeds. After the end of the 19th century, significant breeding programmes diminished, and the breed lost its growing ascendancy. In the course of its spreading in the Carpathian-basin the breed has been adapted to the different geographical and climatic conditions. They never became dominant because their expansion was limited by the presence of the Hungarian Zackel (Racka) and the appearance of the Merino. At the end of World War II, a small number of native animals that had been maintained made it possible to establish a gathered flock of 200 ewes in Karcag in 1950. This limited stock can be considered as a base and starting point of the national gene conservation programme in the Tsigai breed (Gáspárdy, 2004).

Two different variants of the Tsigai are distinguished nowadays. One of them is the original (native), being the gene reserve, while the other is selected for milking. The latter variety came from the Southland, and these ewes have been mated continuously with breeding rams from this region (Zombor/Sombor and Plivniča) ever since. It is believed that the milking Tsigai has some blood from other breeds: this is the reason that it is officially registered by the Hungarian Association of Sheep Breeders as a new breed. In the traditional native breeds the maintenance has a crucial point to recognise and preserve the rare or flock-specific genotypes, even if they are carrying unfavourable exterior or production-linked traits, or prion genotype (Fésüs et al., 2004).

Cattle breeders have long believed in special attributes of certain maternal lineages, often referred to as cow families. The mitochondria provide a possible mechanism of cytoplasmic inheritance, being inherited exclusively through the maternal lineage, containing a closed loop of DNA coding for genes for proteins of the electron transport chain, essential for producing ATP from ADP (Anderson et al., 1982). Each cell contains many copies of mitochondrial DNA (mtDNA) which are identical and shared by all members of the maternal lineage (Gibson et al., 1997).

The bovine (Anderson et al., 1982) and the ovine (Hiendleder et al., 1998) mtDNAs are the only complete artiodactyl mtDNAs reported so far. The difference between the control region (cr) of *Bos* and *Ovis*, excluding the repeated region, was found as 27.6% by them. Hiendleder et al. (1998) also stated the major *O. aries* haplogroups. The length of the complete ovine mtDNA (haplotype B) presented is 16,616 nucleotides (nt). Meadows et al. (2007) discovered 5 different haplogroups among sheep breeds from the Near-East and New Zealand. Clade A has been found in two breeds from central Asia (Karakul/Kazakhstan and Gizarr/Tajikistan) as well as in three breeds sampled in New Zealand (Romney, Coopworth, and Merino). Clade B haplotypes have been observed in a range of breeds from Europe, the Near East, and New Zealand, and includes sequences derived from European mouflon.

Tapio et al. (2006) revealed geographical patterns in the distribution of haplotypes. First, Group C was present in the Caucasian and Central Asian areas but absent in the eastern fringe of Europe. A second recorded pattern was the absence of Group A in the 4 studied populations from south-eastern Europe. In Asia the most frequent haplotype is the Group A, although in Europe the B haplotype is typical. In a study (Meadows et al., 2011) the different haplogroups were examined based on the full sequence of the mtDNA. A major focus for the study was comparison of mtDNA sequence between domestic and wild sheep. An investigation was conducted in Croatia (Ferencakovic et al., 2013) by sampling 21 mouflon rams all over the country and mtDNA haplotypes were identified. All mouflons had mtDNA haplotype B. These data support a quite homogeneous maternal origin of East Adriatic sheep, which is a characteristic of European breeds.

In this study we carried out a survey among the Hungarian Tsigai variants based on the mtDNA sequences. Our aim is to determine the connections between the flocks and estimate the genetic variability within the populations, and to classify the haplotypes of the Tsigai variants.

MATERIAL AND METHODS

In order to characterize the different variants of the Tsigai breed in Hungary we chose the flock from Kardoskút (KM) and Csanádpalota (CS) to represent the lowland type, the animals from the mountain type (BP) took part in the investigation, too. Individuals were selected from Debrecen (DB), from Cegléd (TC) and from Gödöllő (SF) to visualize the variant of Csóka, milking, and yellow-headed, respectively. The maternal families were established based on the herdbook data of Hungarian Association of Sheep and Goat Breeders' recorded from 1995. The most ancient families (with 7, 8, 9 generations) were involved in the analyses. Altogether 81 blood samples were taken from two members of each family, using EDTA-tubes. The samples were stored at -20°C until further processing. DNA was purified using SIGMA GenElute Blood Genomic DNA Kit according to the manufacturer's recommendation. 25 µl reaction mixture was prepared containing 2.5 µl dNTP, 2.5 µl buffer, 1.5 µl MgCl, 2 µl primer, 1 µl BSA, 0.4 µl Taq-polimerase (Thermo Scientific) and ultra purified water.

According to Meadows et al. (2007) primers CR-F 5'-AACTGCTTGACCGTACATAGTA-3' and CR-R 5'-AGAAGGGTATAAAGCACCGCC-3' were used to amplify a 1059 bp fragment part of the mtDNA control region (AF010406; Hiendleder et al. 1998, 15983-592 nucleotide). The PCR program was the following: 6 cycles 94°C 30s - 54°C 30s - 72°C 45s, 6 cycles 94°C 30s - 53°C 30s - 72°C 45s, and 18 cycles 94°C 30s - 52°C 30s - 72°C 45s. The product was purified using the SIGMA GenElute PCR Clean-Up Kit, and sequenced.

The results were aligned and analysed with MEGA6 (Tamura et al., 2013) software. Analyses were conducted using the Maximum Composite Likelihood model and nucleotide diversity was calculated within and between groups (breed variants). By the use of PopART (http://popart.otago.ac.nz) median-joining network (Bandelt et al., 1999) was designed to reveal the haplotypes and linkages among the individuals.

RESULTS

After aligning and trimming the sequence we got a segment with 1059 nucleotides (AF010406; positions 15983-592). Differing nucleotides were found at 98 sites among all the animals (81 individuals), 47 of these were singletons. The number of differing nucleotides was various in the flocks: DB: 65, KM: 32, CS: 27, BP: 11, SF: 10, TC: 20. The presence of the haplotypes in the breed variants are shown in Table 1. The relative frequency of the haplotypes is high, so most of the individuals represent an independent haplotype.

Table 1. Prevalence of haplotypes in the Tsigai flocks

Flocks	Number of animals	Number of haplotypes	Frequency of haplotypes, %
KM	5	5	100
BP	6	6	100
CS	24	21	87.5
SF	5	4	80
TC	5	5	100
DB	36	30	83.3
overall	81	65	80.2

The within group distances from the average nucleotide substitution were the followings: DB: 0.007; KM: 0.014, CS: 0.004, BP: 0.005, SF: 0.004, TC: 0.010. According to these results, it became clear, that the KM and TC flocks show the highest variability; these flocks have the most diverse genetic background. The number of base substitutions per site from the average of overall sequence pairs between groups is shown in Table 2. There was no great difference found between the populations CS, SF and BP, so we could assume that these flocks share common ancestors.

Table 2. Estimates of evolutionary divergence over sequence pairs between groups

	KM	BP	CS	SF	TC	DB
KM	0	0	0	0	0	0
BP	0.011	0	0	0	0	0
CS	0.010	0.004	0	0	0	0
SF	0.011	0.005	0.004	0	0	0
TC	0.014	0.009	0.008	0.008	0	0
DB	0.012	0.006	0.006	0.006	0.010	0

The median-joining network was constructed based on the sites which were informative for the haplogrouping. The comparison with the data from GenBank revealed that most of our samples (93.8%) belong to haplogroup B, in 42 cases the animals showed total correspondence with the reference sequence B (DQ852175.1). Five animals (6.2%; 2 DB, 2 TC, 1 SF) were found, which seemed to be closer to the haplotype A (DQ852101.1). A single sequence (CS) differed at 4 positions from both the haplotypes B, and A of the GenBank database.

The 81 samples demonstrated 12 main haplotypes, a dominant number of the investigated animals (51.9%) belonged to haplogroup B. It occurred that animals originating from different flocks shared the same haplotype, e.g. DB and CS. There were some haplotypes consisting animals from the same flock.

DISCUSSION

The notable number of differing nucleotides (98) in the control region refers to the diversity of the investigated populations. The same can be stated about the individual flocks, especially the KM. A greater nucleotide diversity found in the TC reflects the wider genetic background of this population. The resemblance between the DB and TC can be caused by the common geographical origin and thus shared environmental habitat (Southland – Vojvodina). At the same time, the differences among the individuals and between the variants were limited to a few nucleotides. Our conclusion is that the examined populations were not so distantly related to each other than expected previously, according to their maternal background.

Most of our samples belonged to the ovine haplogroup B, and only a few of them showed resemblance to haplotype A. These facts support a European maternal origin of the Hungarian Tsigai decisively. The haplotype A could originate from Asia. Our results based on mtDNA cr are partially differing from the results in previous studies based on microsatellite polymorphisms. The reason for this can be explained with the cytoplasmic inheritance, so the today's populations have dissimilar maternal and paternal background. It is conceivable that many specialities of the variants/flocks originate from the ram side. The selection for breeding and mutations can also be responsible for the differences between the Tsigai variants.

CONCLUSIONS

We consider exploring the genetic background of maternal lineages in other traditional sheep breeds as an important task in the future. We are planning to carry out further investigations on the mtDNA cytb coding region. In the preservation of native breeds - such as the Tsigai and its variants - the consideration of the mtDNA variability gets an important role. A more intense focusing on the maternal side is motivated also by the fact, that females are present at greater number than males, respectively they remain in breeding for a longer period of time, so they can be the depositaries of realization and maintenance of genetic diversity at larger extent. By estimation of the mtDNA variability we want to support the effective within family selection, and give guidance to the breeders. On the course of gene preservation work, the maternal families must be respected, especially to preserve the members of the ancient families.

ACKNOWLEDGEMENT

This research was funded by the „Research Faculty Fund" (KKUK-15269). We would like to thank all farmers for the support throughout the field work, the Hungarian Association of Sheep and Goat Breeders for giving us the pedigree data, and all co-workers for their help.

REFERENCES

Anderson S., de Bruijn M.H.L., Coulson A.R., Eperon I.C., Sanger F., Young LG. 1982. Complete sequence of bovine mitochondrial DNA. Conserved features of the mammalian mitochondrial genome. J. Mol. Biol., 156: 683–717

Bandelt H., Forster P., Röhl A. 1999. Median-joining networks for inferring intraspecific phylogenies. Mol Biol Evol 16: 37–48

Ferencakovic M., Curik I., Perez-Pardal L., Royo L. J., Cubric-Curik V., Fernandez I., Alvarez I., Kostelic A., Sprem N., Krapinec K., Goyache F. 2012. Mitochondrial DNA and Y-chromosome diversity in East Adriatic sheep. Animal Genetics 44: 184–192

Fésüs L., Zsolnai A., Horogh G.P., Anton I. 2004. A juhok surlókórja. 2. A priongenotípusok gyakorisága hazai őshonos juhállományainkban. Magyar Állatorvosok Lapja, 126: 670–675

Gáspárdy A. 2004. Hungarian native Sheep: the Tsigai. Living Heritage

Gibson J.P., Freeman A.E., Boettcher P.J. 1997. Cytoplasmic and mitochondrial inheritance of economic traits in cattle. Livestock Production Science 47: 15–24

Hiendleder S., Lewalski H., Wassmuth R., Janke A. 1998. The Complete Mitochondrial DNA Sequence of the Domestic Sheep (Ovis aries) and Comparison with the Other Major Ovine Haplotype. J Mol Evol 47: 441–448

Meadows J. R. S., Cemal I., Karaca O., Gootwine E., Kijas J. W. 2007. Five Ovine Mitochondrial Lineages Identified From Sheep Breeds of the Near East. Genetics 175: 1371–1379

Meadows J. R. S., Hiendleder S., Kijas J. W. 2011. Haplogroup relationships between domestic and wild sheep resolved using a mitogenome panel. Heredity 106: 700–706

PopART, http://popart.otago.ac.nz

Tamura K., Stecher G., Peterson D., Filipski A., and Kumar S. 2013. MEGA6: Molecular Evolutionary Genetics Analysis version 6.0. Molecular Biology and Evolution 30: 2725–2729

Tapio M., Marzanov N., Ozerov M., Cinkulov M., Gonzarenko G., Kiselyova T., Murawski M., Viinalass H., Kantanen J. 2006. Sheep Mitochondrial DNA Variation in European, Caucasian, and Central Asian Areas. Mol. Biol. Evol. 23: 1776–1783

Morphological characterisation of autochthonous Bela Krajina Pramenka sheep

Danijela Bojkovski, Gregor Gorjanc, Mojca Simčič

University of Ljubljana, Biotechnical Faculty, Department of Animal Science, Groblje 3, SI-1230 Domžale, Slovenia

ABSTRACT

Bela Krajina Pramenka is one of the Slovenian autochthonous sheep breeds reared for lamb production. The breed is named after the region located in the southeast of Slovenia. Today, majority of farms can be found in the villages near Črnomelj, Adlešiči and Vinica. Breeding program for the Bela Krajina Pramenka breed was adopted in 2005. The main breeding goals are to conserve the breed and its typical characteristic. The aim of the study was to characterize the conformation traits of Bela Krajina Pramenka sheep compared with measures from the past found in the literature. Conformation traits were collected measuring 132 ewes. Data were analysed by the statistical package R considering age at scoring, gestation stage and breeder. At the age of five years, ewes reached the average body weight of 55.4 kg and average wither height of 68.7 cm. Comparing ewes between first and fifth year of age, when growth of Bela Krajina Pramenka is finished, they achieved 74.5% of body weight and 96.1% of wither height in the age of one year. The majority of ewes had white head with black spots (77%), which were also found on the front (66%) and rear (65%) legs. There were 42% of ewes with horns and 45% without them. More than 85% ewes of Bela Krajina Pramenka had tail that reached the position under the hock.

Keywords: sheep, Bela Krajina Pramenka, conformation traits

INTRODUCTION

Bela Krajina Pramenka is one of the four autochthonous sheep breeds in Slovenia. The population size was estimated on 900 animals in 2014 (Kompan et al., 2015). Due to the low population size and geographical distribution, the breed is considered to be critically endangered (Regulation on conservation …, 2004).

The Bela Krajina Pramenka is an autochthonous sheep breed, which is widespread in the area of Bela Krajina in the southeast part of Slovenia at least 100 years (Figure 1).

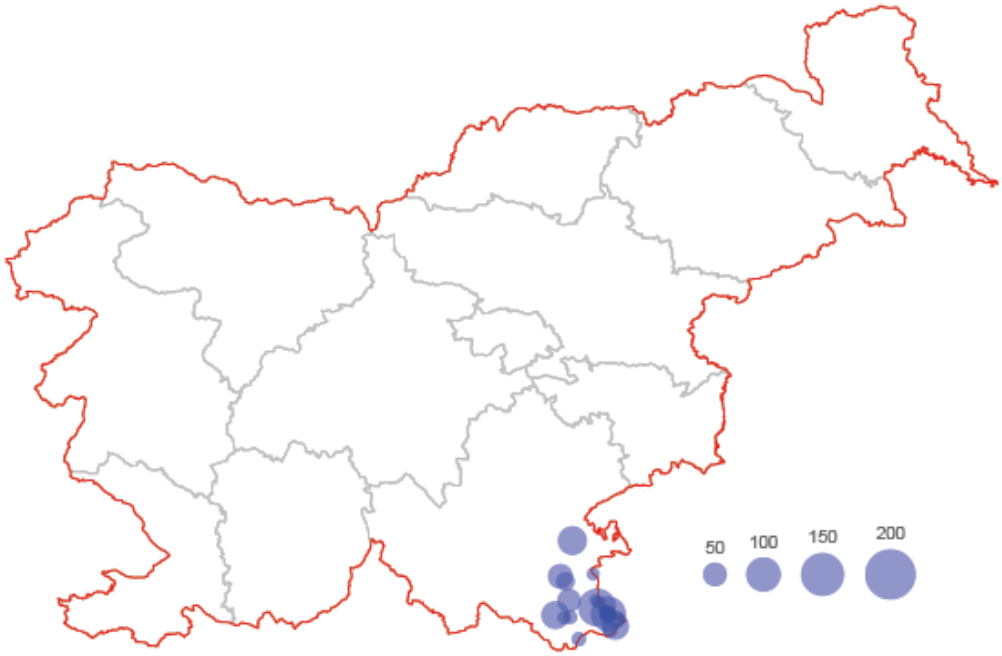

Figure 1: Geographical distribution of Bela Krajina Pramenka sheep in Slovenia

(Žan Lotrič et al., 2013)

The dry climate and poor rearing conditions in the region developed lower body frame of the sheep. Ewes weight around 45 kg, while rams weigh a little more. Adaptation on rearing conditions, especially ability of grazing in sparse rocky areas with ferns and shrubs, is the most important trait of the breed. In the past, the most popular were sheep with the coarse wool, low productivity and small demands. Breeding purpose of Bela Krajina Pramenka is lamb (meat) production (Kompan et al., 2004). The purpose of this study was to characterize morphological traits of ewes of the autochthonous Bela Krajina Pramenka sheep for the first time.

MATERIAL AND METHODS

In total, 132 ewes were measured during the autumn in the year 2006, when animals were in quite good body condition. Ewes of different ages were included in the study and divided in three categories as follows: (a) ewes before first mating or during the first gestation period, (b) ewes after second or third lambing and (c) ewes after fourth lambing. At least ten ewes from every category were included. All animals were located in four farms in the Bela Krajina area (Table 1).

Table 1: Number of farms and recorded ewes of Bela Krajina Pramenka

Farm	Ewes
A	34
B	33
C	31
D	34
Total	132

Very basic recording equipment was used such as tape, stick and calibrated scale. The following measurements were taken with the stick for each animal: wither height, croup height, body length (shoulder to pin bone), body length (wither to pin bone), chest width, chest depth and croup width. Chest girth and cannon bone circumference were taken with the tape. Body weight was taken with calibrated scale. In the same time, wool, head and legs colour were described. The presence of horns and the tail length were recorded as well. Data were analysed using R program (R Development Core Team, 2006). Statistical model included effects of age (linear regression), gestation stage (semiparametric regression) and breeder (fixed effect).

RESULTS AND DISCUSSION

In total, 132 ewes were measured in the average age of 59 months. The LSM values for conformation traits of ewes in the age from one to five year are presented in the Table 2. Table 3 includes the percentage of adult size for each conformation trait in the age from one to five years as well. The average body weight of recorded ewes in the first year was 41.3 kg and the adult body weight (55.4 kg) was reached in the age of five. The average wither height and croup height of one year old ewes were 66.0 cm and 66.4 cm, respectively. The adult size of wither and croup height (68.7 cm) were reached in the age of five. On the other hand, body length (shoulder to pin bone; wither to pin bone) reached its adult size (72.5 cm; 63.8 cm) in ewes at the age of four years, respectively. Chest width and croup width of one year old ewes were 20.0 cm and 17.5 cm and reached their adult size (22.7 cm and 20.4 cm) in the age of four. The adult size of chest depth and chest girth of Bela Krajina Pramenka ewes were 32.7 cm and 95.9 cm. Cannon bone circumference was 7.6 cm in the ewe's age of two years, when reached the adult size as well.

Križnik (1954) recorded lower wither height (63.9 cm) and lower body length (shoulder to pin bone, 65.1 cm) of four to five years old Bela Krajina ewes in the year 1954. In the last fifty years, the wither height of Bela Krajina Pramenka increased for 4.8 cm and body length for 7.4 cm in average. The average body frame of ewes recorded in 2006 was larger to ewes recorded in the year 1954.

Table 2: LSM (Least Square Means) of conformation traits of ewes in the age from one to five years

Conformation traits	**LSM**				
Age (years)	1	2	3	4	5
Body weight (kg)	41.3	48.9	53.6	54.7	55.4
Wither height (cm)	66.0	67.5	68.3	68.6	68.7
Croup height (cm)	66.4	67.6	68.2	68.5	68.7
Body length (shoulder to pin bone, cm)	67.0	70.6	72.3	72.5	72.4
Body length (wither to pin bone, cm)	58.1	61.4	63.1	63.8	63.8
Chest width (cm)	20.0	21.8	22.6	22.7	22.5
Croup width (cm)	17.5	19.2	20.0	20.4	20.4
Chest depth (cm)	28.7	30.5	31.8	32.5	32.7
Chest girth (cm)	86.8	92.9	95.1	95.9	94.3
Cannon bone circumference (cm)	7.5	7.6	7.6	7.6	7.6

Table 3: The percent of adult size of each recorded conformation trait in different ages

Conformation traits	**The percent of adult size (%)**				
Age (years)	1	2	3	4	5
Body weight	74.6	88.3	96.8	98.7	100.0
Wither height	96.1	98.3	99.4	99.9	100.0
Croup height	96.7	98.4	99.3	99.7	100.0
Body length (shoulder to pin bone)	92.4	97.4	99.7	100.0	99.9
Body length (wither to pin bone)	91.1	96.2	98.9	100.0	100.0
Chest width	88.1	96.0	99.6	100.0	99.1
Croup width	85.8	94.1	98.0	100.0	100.0
Chest depth	87.8	93.3	97.3	99.4	100.0
Chest girth	90.5	96.9	99.2	100.0	98.3
Cannon bone circumference	98.7	100.0	100.0	100.0	100.0

During the process of measuring, the coat (wool) colour and the colour of the head and legs were described as well. Bela Krajina Pramenka has almost all body covered with the wool, from ears till the hock. They had wool also on the head and on the belly. The wool is rough and fringed, typical for all Pramenka breeds. Among 132 ewes, 31% of them had white wool colour, while 69% ewes had white wool with black and/or brown strands. The head and legs of Bela Krajina Pramenka are according to the breed standard more or less covered with black spots. However, 77% of recorded ewes had black spotted head, while some of them had completely black (21%) or white (2%) coloured head. The majority of recorded ewes had black spots also in the front (66%) and in the rear (65%) legs. Ewes with completely black front (19%) and rear (12%) legs and ewes with completely white front (15%) and rear (23%) legs were also found.

Likewise, the presence of horns in the head of Bela Krajina Pramenka ewes was recorded. Among all 132 ewes, 42% of them had horns and 45% were without horns. Some ewes (13%) had just germs of horns.

The length of the tail was recorded according to the hock position. More than 85% ewes of Bela Krajina Pramenka had long tail, which reached the position under the hock. Remaining 11% of animals had the end of the tail in the position of the hock and 4% were tail did not reached the hock. The tail was completely covered with the wool. Križnik (1954) found that long tail reaching the position under the hock in the whole population of Bela Krajina Pramenka in the year of 1954.

CONCLUSION

Recorded Bela Krajina Pramenka ewes had larger body frame compared to ewes in the population from 1954. The average body weight of recorded ewes in the first year was 41.3 kg and the adult weight (55.4 kg) was reached in the age of five. Likewise, the average wither height of one year old ewes was 66.0 cm, while the adult wither height (68.7 cm) was reached in the age of five. The most frequent coat colour was white with black and/or brown strands (69%). The majority of recorded ewes (77%) had black spotted head as well as black spotted front (66%) and rear (65%) legs. Horns were found in 42% of ewes. More than 85% ewes of Bela Krajina Pramenka had long tail that reached the position under the hock. This study was the first morphologic characterisation of the breed which enables comparison with others Pramenka breeds. Collected data will be used in the conservation and selection programmes for the breed.

REFERENCE

Kompan D., Bojkovski D., Žan Lotrič M., Terčič D., Malovrh Š., Potočnik K., Cividini A., Simčič M. 2015. Program varstva biotske raznovrstnosti v slovenski živinoreji: poročilo za leto 2014. Domžale: Biotehniška fakulteta, Oddelek za zootehniko.

Kompan D., Žan Lotrič M., Cividini A., Komprej A., Bojkovski D., Birtič D., Drašler D., Simčič M., Gorjanc G., Čepon M., Potočnik K., Krsnik J. 2004. Rejski program za belokranjsko pramenko. Domžale, Biotehniška fakulteta, Oddelek za zootehniko, Zveza društev rejcev drobnice Slovenije: 63 str.

Križnik V. 1954. Ovčereja v Beli Krajini. V: Poročilo o delu za leto 1953. II. del: Živinoreja. Ljubljana, Kmetijski poskusni in kontrolni zavod Slovenije v Ljubljani: 111-117.

R Development Core Team. 2006. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org (9. feb. 2008)

Regulation on conservation of farm animal genetic resources, 2004. Official Journal of the Republic of Slovenia, No. 90/2004 and 88/14.

Žan Lotrič M., Gorjanc G., Kompan D. 2013. Geographical distribution of sheep and goat breeds in Slovenia. Slovenian veterinary research, 50, 4: 183-191

Phenotypic and genetic variability of some morphological traits of Nonius horse in Serbia

Ljuba Štrbac[1], Snežana Trivunović[1], Mirjana Baban[2]

[1]Faculty of Agriculture, University of Novi Sad, Trg Dositeja Obradovica 8, Novi Sad, Serbia
[2]Faculty of Agriculture, Josip Juraj Strossmayer University of Osijek, Kralja Petra Svačića 1d, Osijek, Croatia

ABSTRACT:

In the process of intensification of livestock production, low-productive breeds are suppressed and less competitive. On the other hand, cares about these breeds is of great importance because they represent a source of genes for improving health, resilience and better adaptation to specific environmental conditions. Due to increased application of technology and mechanization in the agriculture and transport, Nonius has lost its former role, which ultimately resulted in negative effect on the population size. In order to prevent further population reduction and loss of genes, Nonius are included in the program for the conservation and sustainable use of genetic resources of domestic animals. Breeding objective is to preserve strong harness horses, noble and unique looks with distinctive race characteristics of exterior, correct movement for the harness and the riding, which is usable for traditional agricultural work and equestrian tourism, therapeutic riding, recreation etc. The average height at withers (HW), chest girth (CG) and cannon bone circumference (CBC) were 158.33 cm, 181.97 cm and 21.40 cm, respectively. Heritability estimates were 0.58 for HW, 0.52 for CG and 0.55 for CBC. The high heritability estimates indicate that selection based on horse phenotypic value induce faster genetic change in these traits and that animal's phenotype is a good indicator of genetic merit or breeding value.

Keywords: Nonius horse, population size, breeding objectives, morphological traits, phenotype and genetic parameters

INTRODUCTION

Changes in the conditions and ways of human life also reflected at the horse use value. Formerly, horses were the main work force in agriculture, while today most breeds are for sports competitions, or simply as a hobby. Bešlin et al. (1997) suggest that the intensification of livestock production in recent decades disappeared many native breeds of horses in Europe, and in Serbia. The whole situation induces necessity to take measures of preservation, especially the endangered breeds. In order to prevent further reduction of horse numbers and the loss of genes that may be important in the future, the Nonius are included in the program for the conservation and sustainable use of genetic reserves of domestic animals.

The founder of the breed, Nonius senior an Anglonorman stallion born in France, came into Hungary in 1816. In the framework of inbreeding, four lines were established and the small impact of Thoroughbred improved the elegancy of the breed and it developed a calm harness horse, useful in artillery and agriculture. Endurance of Nonius horses was proven in distance driving (100 km) competitions. Constant pedigree and genetic stability make the breed available for commercial crossing. In Serbia, breeding was started at the stud farm Karađorđevo in 1885, as a moving part of stud farm Mezohegyes. During the breeding, Thoroughbreds were mostly used. Depending on the size of the impact of Thoroughbreds, two types of Nonius were created: lighter type (higher impact), finer skeletons and lively temperament, and the heavier type (less influence), which was much larger and stronger intended primarily for agricultural work. The vast majority of Nonius horses are black, or dark bay or brown, either unmarked or modestly marked with white. The breed is also known for the heavy but proportional head with a convex profile called either a ram's head or Roman nose. The breed exhibits traits common to heavy-boned driving and light draft horses: powerful and arched high-set neck, broad and muscular back, open but powerful loin, deep and sloping hindquarters. The chest is rather broad than deep, and is usually shallower than the hindquarters. The hooves and joints are large and the legs are dry. Nonius horses stand between 155 and 165 cm. The height can be divided into small (up to 159 cm, measured with a stick or up to 165 cm, tape measured) and the large Nonius horse who are above these measures. The average weight of a stallion is about 600 kg while the mares are a little lighter and reaches about 550 kg. One of the heaviest warmblood driving horses, the ideal Nonius has a chest girth of 180 – 210 cm and a cannon bone circumference of 22 – 24 cm. Nonius horses are also known for a kind, even temperament and great willingness and capacity for work both in harness and under the saddle. In addition, they are usually easy keepers with high endurance. Today they are used in agricultural work, light draft and the sport of combined driving. The Nonius is slower and less suitable for other riding sports like dressage and show jumping than lighter horses. Researches related to the Nonius are rare. Bene et al. (2014a,b) studied some effects on the gestation length of traditional horse breeds and on the live weight and body measurement of adult brood mares from different genotypes in Hungary. Mihok et al. (2004) in their research were studied the genetic distance among traditional horse breeds in Hungary. Maftei et al. (2011) were analysed reproductive isolation and age structure of Nonius horse from Izvin studfarm in Romania. The aim of this paper was to analyse the breeding of Nonius horses with special reference to the population size, breeding objective, as well as phenotypic and genetic variability of morphological traits (height at withers, chest girth and cannon bone circumference) within the controlled population in the Serbia.

MATERIAL AND METHOD

For this research, the database of the Centre for Animal Breeding in Vojvodina was used. The study included data of 60 horses. Withers height was measured by the Lydtin stick, while chest girth and cannon bone circumference was measured by measuring tape. Means and variability of traits for horses older than 5 years were obtained by descriptive statistics using the software Statistica version 12 (StatSoft, 2014). Estimation of genetic parameters was conducted for the whole population using the Wombat (Meyer, 2007), using multi-trait animal model. The statistical model was:

$$y_{ijkl}=\mu+S_i+B_j+a_k+e_{ijkl}$$

where:

y: measured traits,
μ: general average,
S: the fixed effect of sex (i=1, 2),
B: the fixed effect of birth year (j=1,...16),
a: the random animal effect,
e: random error.

RESULTS

Change of Nonius use value has resulted in a drastic reduction in population size in recent decades. According to the data from Table 1, issued by the DAD - IS (FAO, 2014) compared to the 2012 there were no changes in the population size. However, if we look at the period of 1993 - 2009 the size of the population has an increasing trend, while in the period from 2009 to 2014 has stagnated. No matter, the COAR's reported that the status of this breed is critically endangered.

Table1. Population size of Nonius Horse in Serbia (Source: DAD-IS FAO)

Number	Year						
	1993	1999	2004	2008	2009	2012	2014
Total	85-100	64-100	50-100	50-100	100-500	100-500	100-500
Stallions	35	23	10	10	25	20	21
Mares	50	19	40	40	55	80	25

*Status: Critically endangered (COAR)

Table 2 shows the data from the Centre for Animal Breeding, Department of Animal Science, Faculty of Agriculture, Novi Sad, and refer to the active population size of Nonius horses in Vojvodina.

Table 2. Active population size of Nonius horse in Serbia (Source: Centre for Animal Breeding in Vojvodina)

Year	Stallions	Mares	1 - 3 year old	Foals	Total
2011	18	20	19	14	71
2012	19	21	27	5	72
2013	18	21	20	12	71
2014	14	20	22	10	68

Table 3 presents the results related to the phenotypic variability of basic exterior measures withers height (WH), chest girth (CG) and cannon bone circumference (CBC) for horses older than 5 years, both sexes together and separately males and females.

Table3. Phenotypic variability of measured traits for horses older than 5 years

	Traits	*N*	$\bar{X}$	$S_{\bar{X}}$	*Min*	*Max*	*SD*	*CV*
Total	WH	30	158.33	0.87	148.00	168.00	4.78	3.01
	CG		181.97	1.59	169.00	201.00	8.69	4.78
	CBC		21.40	0.27	19.00	24.00	1.45	6.79
Stallions	WH	15	160.07	1.19	148.00	168.00	4.58	2.87
	CG		183.93	2.30	172.00	201.00	8.92	4.85
	CBC		21.40	0.29	19.00	23.00	1.12	5.24
Mares	WH	15	156.60	1.15	150.00	167.00	4.45	2.84
	CG		180.00	2.14	169.00	195.00	8.28	4.60
	CBC		21.35	0.46	19.00	24.00	1.76	8.25

WH = withers height, CG = chest girth, CBC = cannon bone circumference

Analysing both sexes together, withers height of the animals older than five years has been 158.33 cm, chest girth 181.97 cm and cannon bone circumference 21.4 cm. The largest variation interval and the standard deviation were found at the chest girth trait. This may be due, as depending this trait on age, nutritional status and condition of animals at the time of measurement. The coefficient of variation was the highest at the cannon bone circumference and compared to the chest girth was higher by 1.4 times, compared to the withers height of 2.3 times.

Table 4 presents the results related to the estimation of genetic parameters (heritability and genetic correlations). All heritability value was high (0.52 - 0.58), while genetic relationships between measured traits were positive.

Table 4. Heritability estimates (on the diagonal), and genetic correlation (above diagonal) for measured traits

Traits	WH	CG	CBC
WH	0.58	0.17	0.68
CG		0.52	0.51
CBC			0.55

WH = withers height, CG = chest girth, CBC = cannon bone circumference

DISCUSSION

Population size and breeding objective

Breeding of Nonius in Serbia is concentrated on the territory of Vojvodina, which is mostly represented in the horse farm Karađorđevo - VU Morović (50 horses), while the rest of the horses are owned by a relatively small number of individual breeders. Except in Serbia, Nonius is breeding in Hungary, Slovakia and Romania. Breeding objective is to preserve breeding of strong harness horses, noble and unique looks with distinctive race characteristics of exterior, correct movement for the harness and the riding, which is usable for traditional agricultural

work and equestrian tourism, therapeutic riding, recreation etc. In Serbia, horses are mainly used for riding; the draught power of horses is used to a lower extent. Recently increased interest has been observed in breeding traditional horse breeds like the Nonius. Nonius is autochthonous and locally adapted breed in Serbia under the state incentives. The situation is extremely critical in horse breeding and concerns not so much the reduction in number but mainly the rapid decrease of breeds like the Nonius.

Phenotypic and genetic variability of measured traits

The conformation scoring of horses serves useful pieces of information for breeder, which is not replaceable with other examination. However, conformation is a little bit subjective, but together with body measurements and measurement-indices it can be an objective source of character of the animal. Relationship exists among conformation, performance and feasibility in all species of farm animals especially in the case of horse (Bene et al., 2014). Based on the results of the height at the withers the study population could be classified in a smaller type Nonius (height at the withers less than 159 cm). It was shown that the stallions in relation to females are superior in all three properties. According to Bene et al. (2014), Nonius is one of the largest breeds of warm-blooded horses in Hungary with withers height of 164.7 cm in mares measured by stick and 174.3 cm tape measured. According to their results, among warm blooded genotypes Nonius mares had the largest frame, however the Hungarian Sport Horse was not behind significantly. These results can be explained with the situation that some Nonius mares were used for improving Hungarian Sport Horse. In Slovakia, the height at withers varies between 160 to 172 cm measured by measuring tape, the chest girth of 190 – 208 cm, and the cannon bone circumference 20 - 23.5 cm (Mlýnek et al., 2009). Research related to the genetic variation showed that all three traits have a high heritability. The high heritability estimate indicates that selection based on the horse phenotypic value induce faster genetic change in these traits and that animal's phenotype is a good indicator of genetic merit or breeding value. Genetic parameters for morphological traits of Andalusian horses were investigated in Molina et al (1999). In their studies heritability values ranged from 0.35 to 0.95. In the research of Baban et al. (1998) heritability for withers height, obtained by the method of intraclass correlation, was somewhat higher ($h^2 = 0.32$) compared to the method of regression and the REML method ($h^2 = 0.29$ and 0.26, respectively). The same was estimated for the chest girth and cannon bone circumference. Zechner et al. (2001) estimated values of heritability for height at withers (0.52) and chest width (0.36). The reason for these differences may be in different breeds, in different countries and in different size of the population.

CONCLUSIONS

Due to the increased application of technology and mechanization in agriculture and transport, the horse lost its former role that reflected negatively on the population size. The importance of Nonius as a working horse has decreased, but interest for breeding for recreational purposes, riding and harness grown. However, the size of the population is not satisfactory. The small number of horses could lead to inbreeding, increasing homozygosity and to the loss of certain genes. Because of this, it is required through the implementation of breeding programs to deal with the phenotypic and genetic variability in the population level and planning matings primarily in order to preserve this breed of horses but also increase genetic improvement of the properties defined in the breeding objectives. In addition, improving breeding through the

knowledge of genetic and phenotypic parameters should be topical issue in the view of a small number of studies in Serbia dealt with this issue. The results obtained here might be valuable for the selection scheme in order to gain genetic improvement for some morphological traits of Nonius horse in Serbia.

REFERENCES

Baban M., Rastija T., Caput P., Knežević I., Stipić N. 1998. Estimation of heritability of Lipizzaner horses for morphological traits by means of various methods. Czech Journal of Animal Science, 43, 299–303.

Bene S., Benedek Z., Nagy S., Szabo F., Polgar J. P. 2014a. Some effects on gestation length of traditional horse breeds in Hungary. Journal of Central European Agriculture, 15, 1: 1-10.

Bene S., Kecskes S. B., Polgar P., Szabo F. 2014b. Comparison of live weight and body measurement of adult brood mares from different genotypes in Hungary. Journal of Central European Agriculture, 15, 2: 1-11.

Bešlin R., Jastšenjski S., Jović D., Milić M., Ranković M., Vučinić M., Zlatanović S. 1997.Značaj očuvanja genetičkih resursa u konjarstvu. Savremena poljoprivreda, 1-2, 223-228.

Centar za očuvanje autohtonih rasa (COAR): http://www.cepib.org.rs

Domestic Animal Diversity Information System (DAD-IS): http://dad.fao.org

Glavna odgajivačka organizacijaza AP Vojvodinu. 2014. Glavni odgajivački program u konjarstvu.

Maftei M., Popa R., Popa D., Mărginean G, Vidu L., Vlad I., Gîrlea M, Lăpuşte T. 2011. Partial results regarding the genetic analysis of Nonius horse from Izvin studfarm: reproductive isolation and age structure. Animal Science and Biotechnologies, 44, 1: 278-281.

Meyer K. 2006. WOMBAT. A program for Mixed Model Analyses by Restricted Maximum Likelihood. Journal Zhejiang Uni. Science, 8, 815–821.

Mihok S., Ban B., Jozsa Cs., Bodo I. 2004. Estimation of genetic distance between traditional horse breed in Hungary. In: Conservation genetics of engendered horse breed. EAAP Publications- Bled, Slovenia. 111-121.

Mlynekova E, Halo M, Holy A, Kovalčik E, Horny M, Hreus M, 2009: Analysis of families of Nonius breed in Slovakia, Journal of Central European Agriculture, 10 (4): 427-432.

Molina A., Valera M., Dos Santos R., Rodero A. 1999. Genetic parameters of morphological traits in Andalusian horse. Livestock Production Science, 60, 2-3: 295-303.

StatSoft. 2014. Staistica – version 12

Zechner P., Zohman F., Sölkner J., Bodo I., Habe F., Marti E., Brem G. 2001. Morphological description of the Lipizzan horse population. Livestock Production Science, 69, 163-77.

Growth of Krškopolje pig in different environments

Milena Kovač, Tina Flisar, Špela Malovrh

University of Ljubljana, Biotechnical Faculty, Department of Animal Science, Groblje 3, SI-1230 Domžale, Slovenia

ABSTRACT

Aim of the study was to compare growth of Krškopolje pigs in different rearing conditions. In first experiment (EX1), 30 pigs were reared on forest lawn with shelters. Pigs were additionally fed with byproducts from grain and plant production. In EX2, 42 pigs were housed together in a pen with area of 150 m^2 while pigs in EX3 were housed in four pens in a group of six pigs. Both groups were supplied with high quality hay ad libitum. In EX2, pigs got restricted amount of grain mixture to fulfill energy requirements and pigs in EX3 obtained restricted amount of commercial diet for fatteners. Pigs in outdoor system (EX1) grew too slow, fatteners in EX1 around 350 g/day and pigs before start of EX3 only 207 g/day. Pigs in EX2 were growing 355 g/day before experiment started, and continued to grow over 500 g/day. Pigs in EX3 gained almost 600 g/day. Results confirmed high quality fiber as a good source of protein to achieve modesty growth of Krškopolje pigs. Diversity of weight was larger in poorer conditions and larger groups.

Keywords: growth, Krškopolje pig, different environments

INTRODUCTION

Krškopolje pig (KP) is local breed well adapted to poor environment where pigs are growing well to heavier weights and are declared to have good quality meat and fat from nutritional and technological point of view (Žemva, 2010). The adult body size was between 250 and 300 kg (Ferjan, 1969). The pigs were reared in wooden shelters, mainly in dark. They were fed with different kind of cooked roots, fresh grass or clover and kept on pastures. Today, they are housed mainly in older barns, which need to be accommodated in accordance with minimal requirements prescribed by animal welfare legislation (ULRS, 2010). They are fed with feed produced on the farm, farmers of KP buy most of the time feed components supplying proteins, but seldom complete feeding mixture. In old papers, it is found that KP had ability to use fiber efficiently.

Rearing conditions and especially nutrition have an important role for growth. If the pigs were fed ad libitum with complete diet, they grew fast (Kastelic, 2001) but they become extremely fat. Thus, they are supposed to be fed restrictively. However, growth of KP and their needs for nutrients are not well known and recording of growth performance is not accepted as routine practice yet. While slaughter data is obtained in modern genotypes, the KP pigs are not slaughtered in abattoirs. Because of small herds breeders are less aware of growth potential of KP pigs and their assessment of growth performance can be misleading. As soon as the breeders want to focus on marketing meat products, the efficiency of fattening also become important in extensive systems. Knowledge of growth is directly connected to breeder income independently of the way of marketing their pigs or meat products.

Aim of the paper is to study growth of KP pigs in three different experiments. Although the experiments were done in different rearing conditions the comparison was offering very useful and applicable conclusions.

MATERIAL IN METHODS

Data was obtained from three experiments mainly designed to study meat and fat quality (Žemva, 2010). In experiment 1 (EX1), 16 gilts and 14 barrows born at the end of May 2006 on two farms were placed on forest lawn and equipped with shelters. Therefore, pigs had access to pasture and were fed with byproducts from grain and plant production. Diet composition and its intake were not obtained because it was changed often due to seasonality. Pigs were weighed 3 to 5 times during fattening and slaughtered at 99.8 kg of market weight.

Experiment 2 (EX2) and 3 (EX3) were performed at the Research center at the University of Ljubljana. Both groups were supplied with high quality hay rich in proteins ad libitum. There were 18 barrows and 23 gilts in EX2 housed together in a pen with area of 150 m^2. Pigs were born between May 13th and June 27th 2007 as offspring of 8 sows and one boar. They got restricted amount of grain mixture to fulfill energy requirements. Pigs were weighed 15 times during fattening. In EX3, 18 gilts and 6 barrows were accommodated in 4 pens with solid floor covered by straw. Pigs originated from a farm with outdoor system and were born from May 6th to May 25th 2008. They obtained restricted amount of commercial diet for fatteners.

Statistical model (eq. 1) included sex (S_i), experiment (P_j), and their interaction (SP_{ij}) as fixed class effects and animal without relationship as random. Adjustment to age (x_{ijkl}) was done by linear regression within interaction and within animal accounted for genetic heterogeneity by covariance function. Heterogeneity of residual variance was modeled by Satterthwaite method as applied MIXED procedure in SAS Software v. 9.3 (SAS Inst. Inc., 2011).

$$y_{ijkl} = \mu + S_i + P_j + SP_{ij} + b_{ij}(x_{ijkl} - \bar{x}) + a_{ijk} + b_{ijk}(x_{ijkl} - \bar{x}) + e_{ijkl}$$

RESULTS

Pig growth before experiments is described only by descriptive statistics (Table 1) because of different rearing conditions. Piglets in EX1 were weaned almost two months old. EX1 started with pigs weighed on average 28 kg at 109 days of age. Thus, they grew 255 g/day. Gilts were growing 10% slower than barrows, while some of the fastest growing gilts were kept for replacement.

Table 1: Averages and (±) standard deviations of arrival pigs

Experiment	Sex	No. pigs	Age at weaning (days)	Age at start (days)	Range (days)	Weight on start (kg)	Daily gain (g/dan)
EX1	Barrows	14	56.9	108.6	15	29.6±5.6	273±54
	Gilts	16	59.9	108.5	13	26.0±5.1	240±48
EX2	Barrows	23	58.4	135.9	44	49.2±8.3	360±56
	Gilts	19	57.3	140.7	45	48.8±6.9	351±58
EX3	Barrows	6	62.5	175.2	19	36.2±4.8	207±27
	Gilts	18	51.9	180.5	19	37.3±3.3	207±21

Pigs in EX2 originated from one farm were very diverse because age ranged for 45 days (Table 1). They were suckling for almost two months. At the beginning of experiment, they were one month older, growing faster (355 g/day), and almost two (1.8) times heavier than pigs in EX1. We considered that the group was reared properly before experiment started.

In EX3, pigs originated from an organic farm with outdoor system keeping all age groups together. The pigs weighing 37 kg were almost half a year old (Table 1). The weaning time in outdoor systems was not defined well as piglets stay with sows even if they were mixed with other pigs on the pasture. Additional feeding of piglets was not possible in the group where older pigs were dominant not allowing smaller ones to eat enough. Thus, younger pigs did not get sufficient amount of food. The daily gain (207 g/day) was too low: it might be sufficient for suckling piglets but not for weaners. Weaners should be at least two and a half months younger or much heavier at the beginning of EX3.

The body weight during fattening period (Table 2) depended on the farm of origin and age fitted as linear regression within farm-sex interaction. In addition, the random effects animal as well as age fitted as linear regression within animal show significant effect for body weight. Sex and farm-sex interaction did not affect growth of KP pigs.

Table 2: Statistical significance of effects on body weight

Effects	Sex	Farm of origin	Farm-sex interaction	Age nested within interaction	Animal	Age nested within animal
Type	fixed	fixed	fixed	fixed	random	random
p-value	0.6189	<0.0001	0.6450	<0.0001	<0.0001	<0.0001

Changes of body weight during experiments were shown on Figure 1. While the three experiments started at different ages and weights the results for body weight were shown at the age of 200th day and 300th day (Table 3), which were covered in all three cases.

Table 3: LSM estimates of body weight on 200th day and 300th day after birth and average daily gain during experiments

Body weight		on 200th day (kg)		on 300th day (kg)		Daily gain
Experiment	Sex	estimate	±SEE	estimate	±SEE	(g/day)
EX1	Barrows	66.6	±4.4	104.4	±5.8	378
	Gilts	57.6	±4.1	90.2	±5.3	326
EX2	Barrows	86.9	±3.8	140.7	±4.9	538
	Gilts	84.9	±3.4	137.6	±4.5	527
EX3	Barrows	52.9	±6.7	110.0	±8.7	571
	Gilts	52.8	±3.9	112.7	±5.0	599

The average daily gain during EX1 (Table 3) was only 326 g/day in gilts while barrows grew 52 g/day more. They were kept outdoor getting byproducts of plant production directly on the ground. It is clear that the breeder reached only one third of productivity in experiment of (Kastelic, 2001) where KP pigs were fed ad libitum. Slow growth could also be seen on Figure 1. The pigs have grown moderately (Table 1) before start of EX1. Although they were the youngest and the lightest at the start their sale weights were usual for weaners. Therefore, slow growth was caused by poor fattening conditions.

Pigs in EX2 were arriving older and heavier as usually (Table 1). They continued to grow over 500 g/day (Table 3) as expected due to restricted feeding grain mixture and high quality hay as the only source of raw protein. KP pigs could eat a large amount of hay and utilize proteins from forage to grow moderately.

Pigs in EX3 had the highest daily gain (almost 600 g/day, Table 3). Fatteners were fed with balanced diet with amount adjusted regularly in accordance with growth performance. Nevertheless, their weight on 200th day was less than in EX1 or EX2. Although pigs in EX3 showed compensatory growth, they were lighter at 300 days of age for about 28 kg than pigs from EX2 fed high fiber and low energy diet. Growth of KP pigs in outdoor system (EX1) was not sufficient mainly because feeding of pigs was not accommodated to their needs. Feeding on the ground is not appropriate either because of large losses as well as a possibility of contamination with dirt and pathogenic microorganisms. If the conditions during early growth

were too poor, pigs could not fully compensate growth even under good conditions. Feeding had to be performed such that younger animals have unlimited access to food.

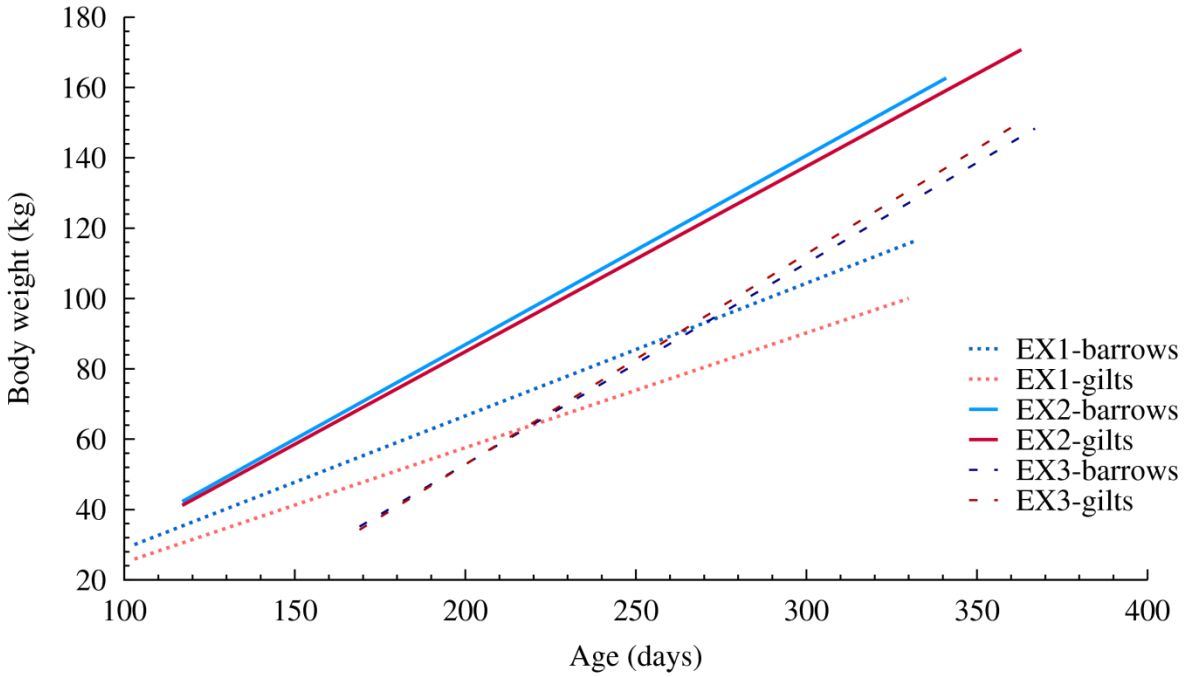

Figure 1: Growth of KP pigs during fattening in the three experiments

Because pigs originated from small farms with continuous farrowing system, it was difficult to form uniform groups already on start (Table 1). In EX1, the age difference was 15 days but the body weight was as low as 21 kg and as high as 40 kg. The group in EX2 originated from one farm and was the largest, therefore, the age difference was 45 days and the weights differed the most with standard deviation of 7.5 kg. The age difference in EX3 was close to three weeks (19 days), the weights differed less because uniformity was required.

Variability of body weight was increasing with age in outdoor system from EX1 (Figure 2) and in indoor system from EX2 (Figure 3). In both groups, there were some very slow growing pigs. They did not reach normal slaughter weight and it is recommended to culled them at younger age. Growth deterioration might be due to illness, lower birth weight or lower growth rate during suckling period or after weaning. Diversification was lower in the last experiment (Figure 4), where pigs were kept in smaller groups sorted by sex and weight.

Another reason for better uniformity in EX3 might be a feeding regime. Diversification of pig growth is larger in case of restricted feeding (Jan 2008, Figure 2) or other limiting factors like insufficient supply of water, lower temperature during cold winter (Dec 2007, Figure 2), constant darkness, bad air quality, low hygiene etc.

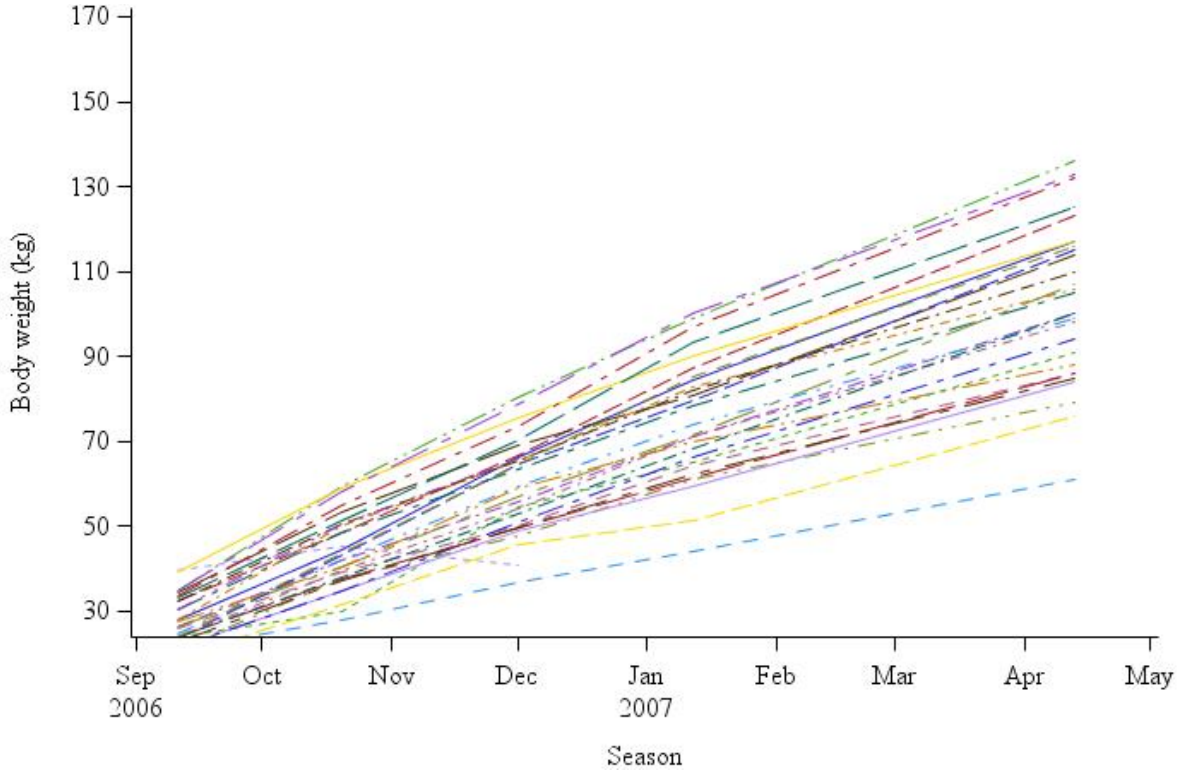

Figure 2: Variation of body weights by age in pigs kept in outdoor system in EX1

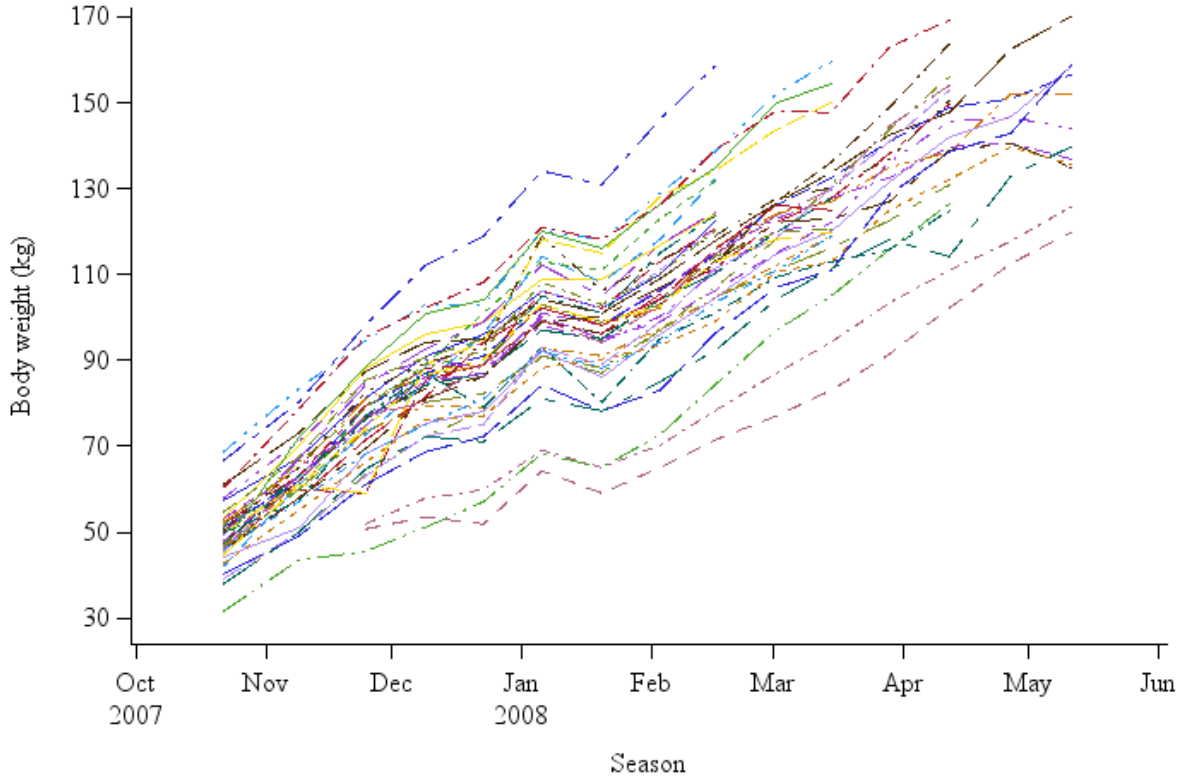

Figure 3: Variation of body weights by age in pigs housed in a large group in EX2

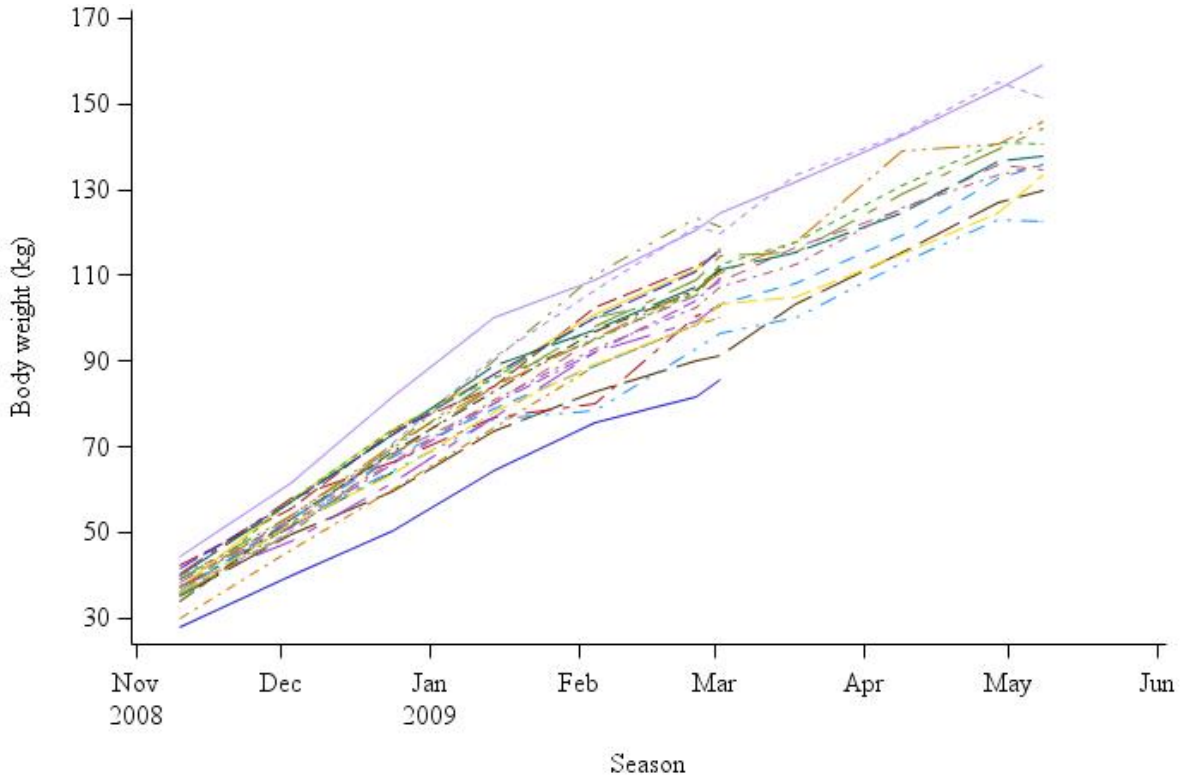

Figure 4: Variation of body weights by age in pigs housed in small groups in EX3

CONCLUSSIONS

The results on growth of Krškopolje pigs in three experiments showed that the diet during fattening period could contain high quality fiber and less energy. High quality forage can be a good source of proteins for fatteners. Suckling piglets and weaners should be fed ad libitum with a diet that fulfill their requirements. They have to have unlimited access to feeders. Supplementary feeding on the ground is not sufficient for any age category of growing pigs in outdoor system. If correctly fed, pigs in organic production would grow modestly.

Diversity of weight was larger in poorer conditions and larger groups. Pigs of different age categories should be kept separately; otherwise, younger animals are not competitive with the older ones.

REFERENCES

Ferjan J. 1969. Uporabnost črno pasastega prašiča. Sod. Kmet., 2: 475–478.

Kastelic A. 2001. Telesna sestava prašičev krškopoljske pasme. Univerza v Ljubljani, Bioteh. Fakulteta, Oddelek za zooteh.: pp 55.

The SAS Software for Windows, Release 9.3. 2011. SAS Institute Inc., Cary, NC, USA.

ULRS 51/2010. 2010. Pravilnik o zaščiti rejnih živali. Ur.l. RS št. 51/2010, 28.06.2010: 7592–7600.

Žemva M. 2010. Kakovost mesa in maščobnega tkiva slovenskih lokalnih genotipov prašičev. Univerza v Ljubljani, Bioteh. Fakulteta, Oddelek za zooteh.: pp 136.

Fertility in Krškopolje sows

Janja Urankar, Karmen Ložar, Milena Kovač, Špela Malovrh

University of Ljubljana, Biotechnical Faculty, Department of Animal Science, Groblje 3, SI-1230 Domžale, Slovenia

ABSTRACT

The aim of study was to examine fertility traits in Krškopolje pig. Data from the central database of Slovenian Pig breeding organization was available between June 1992 and December 2014. Population size was increasing from 50 litters in 3 herds until 2003 to 318 litters from 76 herds in 2013. Average litter size was 9.37 liveborn piglets (SD=3.21 liveborn piglets). Average stillborn (0.9 piglets or 8.8%) and losses during lactation (19.9%) were high. Gilts farrowed at 458 days. Farrowing interval lasted 199.8 days, due to prolonged lactation (49.6 days) and weaning-to-conception interval (34.4 days).

Keywords: Krškopolje pig, sows, litter size, age at first farrowing, lactation, weaning-to-conception interval

INTRODUCTION

The krškopolje pig (KP), the only Slovenian indigenous pig breed (ULRS, 2004), is well adapted to modest rearing and feeding conditions (Šalehar, 1994). Rohrman (1899) among other traits mentioned number of teats (10-12) and litter size (10-12 piglets). According to farmers survey (Prašiči, 1956) litter size of the KP (10.46 piglets born) was comparable to other breeds (10.70 piglets born). Monitoring of productivity for the KP was established in 1956 (Ferjan, 1957). The KP fertility was analyzed in different studies with 11-38 litters involved (Ferjan *et al.*, 1968; Eiselt *et al.*, 1969; Eiselt *et al.*, 1971). The KP had moderate fertility (8.69-10.58 piglets born/litter) with high mortality at farrowing (1.82-2.39 stillborn piglets/litter) and during lactation (24.7-27.3%). In the study with 45 litters, Eiselt and Ferjan (1972) depicted good litter size at farrowing (10.07 born piglets/litter), but according to large number of stillborn piglets (2.13 piglets/litter) and mortality during lactation (26%) number of weaned piglets per litter was small (5.87 piglets/litter). In the same study, crosses between KP and other breeds (Pietrain, Large White, and Landrace) had better fertility than the KP. Afterwards, breed was persecuted for more than 20 years (Šalehar, 1991).

Reconstruction of KP started in 1992. Primary the goals were population size and preserving genetic diversity. The aim of study was to examine fertility performance in the KP since 1992 when data recording began.

MATERIAL AND METHODS

Data between June 1992 and December 2014 was provided by the central database of Slovenian Pig breeding organization. Weaning-to-conception (WCI) was calculated from farrowing interval, lactation length, and gestation. Fertility traits were collected for 507 sows from 123 family farms. Herds were small and rearing conditions were variable including various indoor and outdoor systems. Altogether there were 2921 litters. On average, there were 22 litters per herd with half of the farms having less than 10 litters. The largest farm contributed almost one third of the dataset.

RESULTS AND DISCUSION

Only three farms were included in recording scheme for fertility traits with less than 50 litters (Figure 1) until 2003. Thereafter, the number of farms as well as litters steadily increased as the interest for the KP pigs has been growing due to subsidies for indigenous breeds. The number of gilts and sows was the largest at the end of observed period and is still growing. There were altogether 318 litters in 2013. In other words, the number of litters has increased 7 folds compared to the initial period.

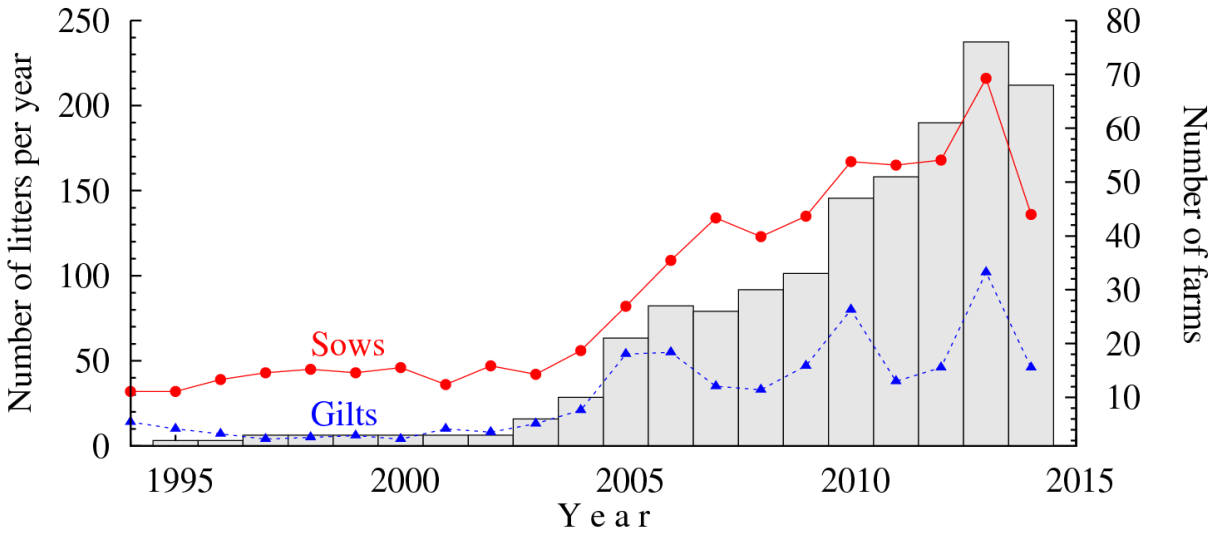

Figure 1: Number of farms and litters per year

The average litter size was 10.27 piglets born or 9.37 piglets born alive (Table 1). Proportion of stillborn piglets was high (8.8%) but not surprising in pens with loose sows often without any protection against crushing of piglets (Danholt *et al.*, 2011). KP sows are also more restless, showing protective behaviour, which is sometimes expressed as aggressiveness against people. Thus, breeders seldom assist at farrowings. The number of weaned piglets was low (7.51). During lactation, almost two (1.86) piglets per litter were lost, thus reducing the litter size for 19.9%. Newborn piglets are smaller and littermates are more diverse increasing piglet losses during birth as well as during suckling period especially in pens without covered and heated nests or when kept outdoor. Standard deviation of litter size was larger than it used to be in modern genotypes. This might be a consequence of more variable production systems practised by less experienced breeders.

Table 1: Descriptive statistics of fertility traits selected

Parameter	**Gilts**	**Sows**	**Avg.**	**SD**	**Range**
Liveborn piglets/litter	7.87	9.90	9.37	3.21	20
Stillborn piglets/litter	0.66	0.98	0.90		15
Piglets weaned/litter	6.55	7.85	7.51	3.18	16
Age at first farrowing (days)	458.3			97.1	500
Lactation (days)		49.6		18.4	132
Weaning-to-conception interval (days)		34.4			948
Farrowing interval (days)		199.8			928

Average litter size varies from 9.8 to 11.2 piglets born/litter (Figure 2). Decrease during recent years is a consequence of establishment of new farms without experience and the higher proportion of first and second parity sows with lower litter size expected. However, we are confident that large part of oscillations was due to very different rearing conditions over herds and years which also affected age at first farrowing (Table 1). Litter size was similar to results reported by Eiselt and Ferjan (1972).

Stillborn piglets per litter can be extracted as a difference between born and liveborn piglets on figure 2. In the first years where there were only three farms, number of stillborn was lower, but for the last 10 year it is oscillating around 0.9 stillborn piglets. Piglet mortality around birth was the highest in period between 2000 and 2002 and might be a consequence of inbreeding depression.

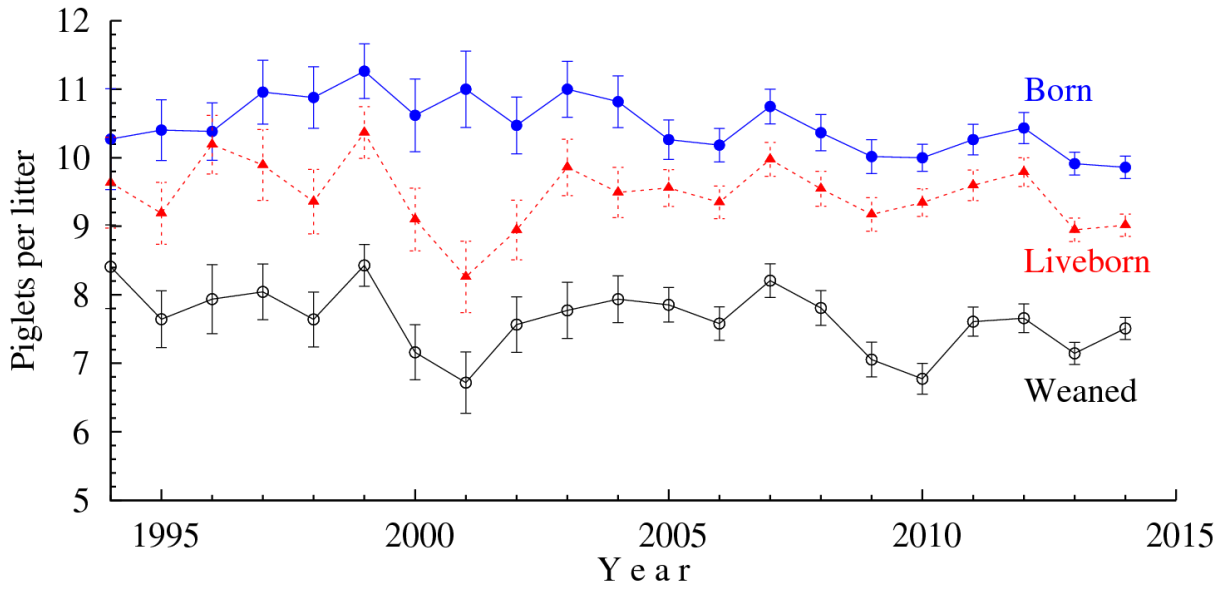

Figure 2: Averages and standard deviations for litter size over years

Mortality during lactation varied from 15% in 2002 to 27% in 2010 (Figure 2). The fastest improvement in litter size can be achieved by improving husbandry, feeding regime for sows and piglets, as well as housing systems, especially farrowing creates to prevent piglet losses. Some improvements can be attained by selection as heritability estimate for number of liveborn piglets in KP (8%, Urankar *et al.*, 2013). Nevertheless, because of small population size, intensity of selection would be rather low.

Gilts farrowed for the first time around average age of 15 months (Table 1), while individual gilts farrowed younger for 2 or 3 months or much older up to 25 months of age. In most years, the average age at first farrowing fluctuated between 450 and 500 days (Figure 3). The age was increasing in periods (for example in years 2006 and 2009) when more gilts were needed when growth performance and onset of puberty as criteria to accept a gilt as breeding animal was ignored. Sometimes breeders mated even slower growing gilts which stayed longer in the herd to obtained number of sow desired. Therefore, breeders of KP pigs did not practice to rear breeding stock on purpose. KP pigs were bought for breeding or fattening at early ages and were mated if breeding gilt was desired. Gilts have often been raised under improper conditions causing slow growth and sometimes even deterioration of the development. If gilts were kept in barren environment and not exposed to boars, onset of puberty would be delayed and low litter size could be expected as well. In experiments (Kovač et al, 2015) it was proven that KP pigs, could easily reach 100 to 120 kg around 200 days of age even in an extensive production system. Thus, gilts could be mated sooner, around age of 8 months, and farrowed two months younger and in a much closer range than in the past.

Lactation in KP sows lasted on the average 49.6 days (Table 1) and was rather variable (Figure 4, left). Short lactations (<21-d) have probably been caused by some severe illness of a sow or her litter. In some herds, they practised weaning of piglets around 30 days of age. Organic farms should not wean piglets before they are 40 days old (ES 2008/889). Thus, expected lactation length in extensive conditions is between 42 and 56 day, but only 52.6% of litters have been weaned within this interval. There are too many prolonged lactation exceeding traditional weaning practice at the beginning of the 20th century when piglets were kept with a sow for eight weeks. More than 10% of lactations have lasted even longer than 10 weeks which represent a large burden to a sow causing serious weight loss and reproduction failure at rebreeding.

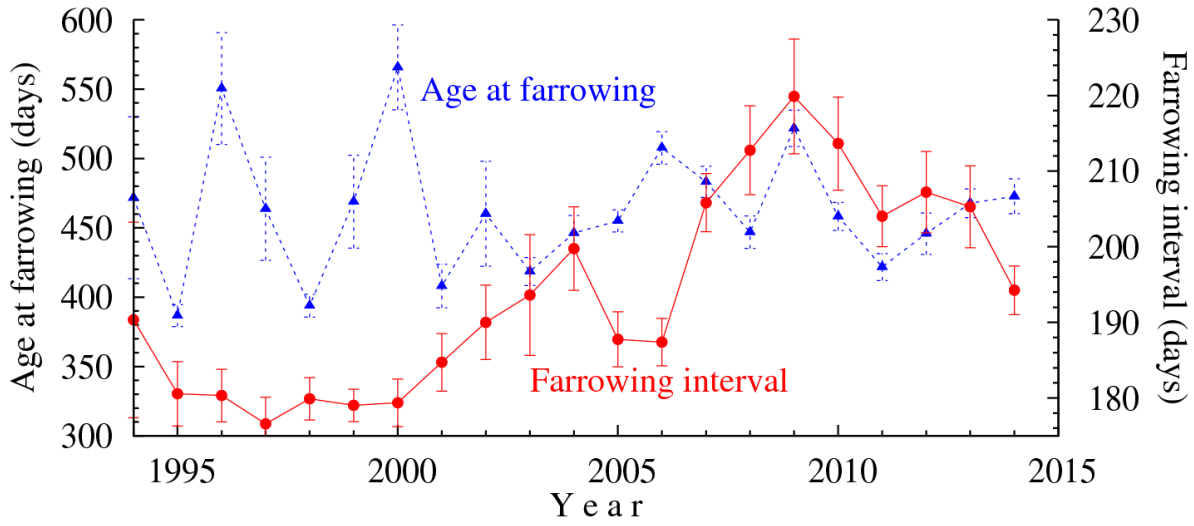

Figure 3: Averages and standard deviations for age at first farrowings and farrowing interval over years

On the average, WCI have lasted 34.4 days (Table 1) and have been varying from -63 days to even more than 885 days (Figure 4, right). Some sows (5.6%) with prolonged lactation have been mated during lactation having a negative WCI. Only 27.7% of sows have been mated within 7 days after weaning. More matings have been done again between 25th and 30th day after weaning skipping the first and mating in the second oestrus. Matings might be postponed for different reasons. If sows lost too much weight during prolonged lactation, a breeder might decide to postpone matings. However, if a sow was excessively thin, onset of oestrus would be delayed for several weeks or even months. In KP pigs, some breeders only bred sows occasionally, whenever they expected larger demand for weaners. Nevertheless, poor management, lack of experience to detect heat and to mate sows on time might be the most important reasons for reproduction failure. In some extreme cases, it is possible that the data were not recorded correctly.

Farrowing interval averaged 199.4 days (Table 1) and the average was steadily increasing from 175 days in 1997 to 220 days in 2009 (Figure 3). The worse average was obtained in year 2009 with large increase of the population size because new herds were included in subsidy program for local breeds. Many breeders were then more focused on the number of sows rather than on their productivity. Although farrowing interval has been reducing since 2009 and has been shortened for more than three weeks, it is still too long. Even in autochthonous breeds living in extensive conditions, sows should farrow twice a year. Farrowing interval in organic production can last around 165 days incorporating 6 week lactation. Breeders of KP pigs should wean the piglets at age predetermined by production system and shortening WCI.

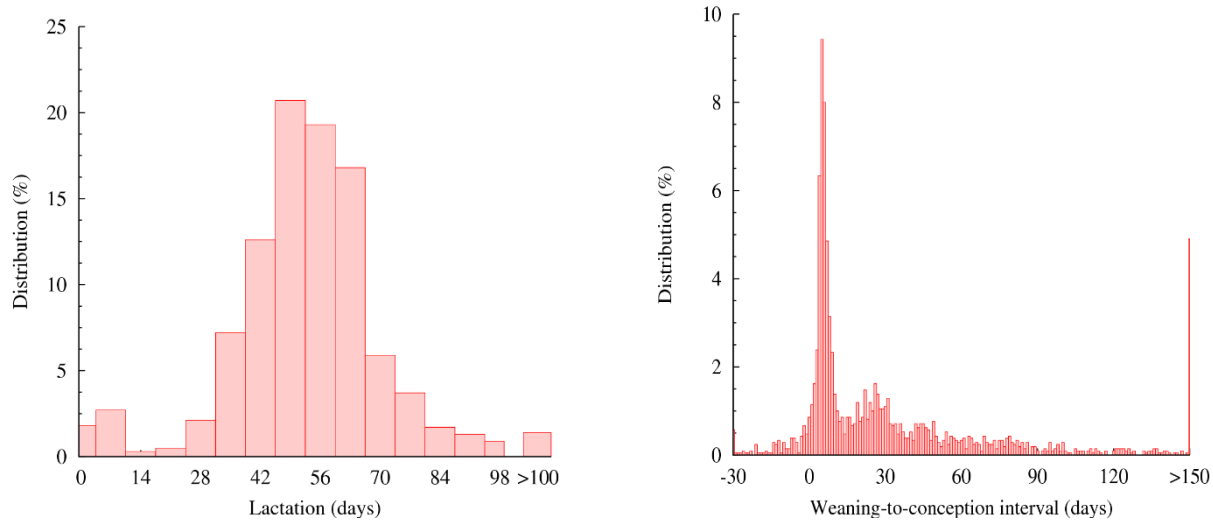

Figure 4: Distribution for lactation (left) and weaning-to-conception interval (right)

Fertility of sows can be improved by management as well as selection. Sows are exhausted by long lactations not being able to conceive before they gain weight back. Fertility is affected by environmental and management factors, so farmers may be the most influential factor affecting animal handling, welfare and productivity (Soede *et al.*, 2011). The productivity can be increased by culling procedure including fertility failure and litter size data as culling objectives.

CONCLUSION

KP was known for good fertility. Litter size at farrowing was moderate, while mortality was high. Gilts were 100-d older at farrowing than expected. Farrowing interval was prolonged. Average lactation was 51 days, but more than 10% of litters were weaned after 10 weeks of age. Sows were mated 34.4 days after weaning. WCI was longer because of seasonal demands for piglets or sow's excessive weight loss during too long lactation. Although breed is adjusted to extensive conditions, management should be improved. Additional attention must be also given to data quality, especially to the verification of pedigree and reliability of reproduction data.

REFERENCES

Danholt L., V.A. Moustsen M.B.F. Nielsen, Kristensen A.R. 2011. Rolling behaviour of sows in relation to piglet crushing on sloped versus level floor pens. Livestock Science 141: 59–68

Eiselt E., Ferjan J. 1972. Proizvodne značilnosti krškopoljskega prašiča. In: Znanost in praksa v živinoreji. III. Zbor prašičerejcev, Bled, 8.-11. maj 1972. Ljubljana, Biotehniška fakulteta, Raziskovalna postaja Rodica: 855-863

Eiselt E., Ferjan J., Osterc S. 1971. Proučevanje reje, kvalitete in genetske konstitucije naših prašičerejskih pasem. Ljubljana, Biotehniška fakulteta, Raziskovalna postaja Rodica: 19 p.

Eiselt E., Ferjan J., Urbas J., Ločniškar F. 1969. Preučevanje reje, kvalitete in genetska konstitucija naših prašičjih pasem. Ljubljana, Biotehniška fakulteta, Inštitut za živinorejo: 18 p.

ES 2008/889. Uredba Komisije ES Št. 889/2008 z dne 5. septembra 2008 o določitvi podrobnih pravil za izvajanje Uredbe Sveta ES 834/2007 o ekološki pridelavi in označevanju ekoloških proizvodov glede ekološke pridelave, označevanja in nadzora. UL L 250, 18.9.2008: 1-84

Ferjan j., Urbas J., Ločniškar F. 1968. Proučevanje kombinacijskih sposobnosti za pitovne in klavne lastnosti pri gospodarskem križanju prašičev. Ljubljana, Kmetijski inštitut Slovenije, Zavod za živinorejo: 14 p.

Ferjan J., 1957. Uspehi prašičerejskih središč Slovenije v letu 1956. Koledar družbe svetega Mohorja 1958: 175-177

Kovač M., Flisar T. 2015. Rast živali krškopoljske pasme v različnih pogojih reje. In: Krškopoljski prašič - od reje do predelave na domu. 1. izd. Domžale: Biotehniška fakulteta, Oddelek za zootehniko, Enota za prašičerejo, Malovrh Š. (ed.), Kovač M. (ed.): 135-144

Prašiči, 1956. Socialistično kmetijstvo, 1-3:56-57

Rohrman V. 1899. Prašičje pleme na Dolenjskem. Kmetovalec, 16: 9–11

Soede N. M., Langendijk, P., Kemp B., 2011. Reproductive cycles in pigs. Anim. Reprod. Sci., 124: 251-258

Šalehar A. 1991. Ostanki krškopoljskega prašiča. Sodobno kmetijstvo, 24: 234

Šalehar A. 1994. The Krškopolje pig. Pig News Information, 15: 59–61

ULRS 2004. Seznam avtohtonih in tradicionalnih pasem domačih živali. Ur.l. RS št. 77/2004: 9309

Genetic profile of Krškopolje pig based on microsatellite markers

Tina Flisar, Daša Jevšinek Skok, Špela Malovrh, Milena Kovač

University of Ljubljana, Biotechnical Faculty, Department of Animal Science, Groblje 3, SI-1230 Domžale, Slovenia

ABSTRACT

The aim of the study was to estimate genetic diversity within Krškopolje pig population. For that reason, 18 microsatellite loci were analyzed, and the results were compared with two major studies of pig breeds diversity. High genetic diversity was found within the population of Krškopolje pig. The STRUCTURE analysis was done where two additional populations (Sattelschwein, Slovenian Landrace line 55) were added. The delta K method revealed five clusters as the most appropriate fit. The STRUCTURE software assigned individuals to five clusters, where Krškopolje pig was divided in three of them. The population of Krškopolje pig included some admixture with Sattelschwein, and neglected admixture with Slovenian Landrace line 55. In future analysis, the sample size of unrelated animals within breeds should be increased in order to achieve better identification of genetic structure in the Krškopolje pig.

Keywords: Krškopolje pig, Sattelschwein, local breeds, genetic diversity, microsatellites

INTRODUCTION

Although European pig industry relies only on few breeds, the rising interest on local breeds started two decades ago mainly through conservation programs. Conservation of farm animal genetic resources (AnGR) refers to wide range of actions undertaken to ensure that the diversity of farm AnGR is maintained and to contribute to food and agricultural production and productivity (FAO, 2000). One of the most effective actions is to supply subsidies, however, it should be considered as a temporary solution. Population maintenance is assured through self-sufficiency. Local pig breeds have good predispositions on local markets, due to consumer demand for quality meat and traditional meat products with known origin.

Slovenia has one indigenous pig breed named Krškopolje pig with the population size around 250 sows and 50 boars. The breed originates from European and Asian wild pig. The first reference of this breed dates back to 1899, when Rohrman reported Krškopolje pig as the most popular breed in Dolenjska region (Rohrman, 1899). Krškopolje pig was commonly admixed with other breeds and Oblak (1938) pointed out that original Krškopolje pig could be found only in the most distant villages. Breed development was affected also by Berkshire, Cornwall, Essex, Wessex and Large White breeds (Stefančič, 1966; Švajger and Bregar, 1991). After the beginning of the eighties, when policy was focused on supporting an import of productive modern breeds, Krškopolje pig breeders were left on their own without any professional support at breeding and rearing. According to AČ (1955) there was an interest of Agriculture Chamber Novo Mesto to reestablish the extension of Krškopolje pig. Crossing Krškopolje pig with the British Saddleback in the middle of 19th century did not succeed. However, breeders were more satisfied with German Saddleback (Sattelschwein), imported in years 1964 and 1970.

In the year 1991, breed was declared as endangered and was included in breeding program, the herdbook was established in the year 1992. Due to small population with five boars only, there was high possibility of inbreeding (Šalehar *et al.*, 1992). Sattelschwein boars (3) and sows (7) were integrated into the population of Krškopolje pig in year 2003. Since then, breeding of Krškopolje pig focused mainly on the reconstruction of exterior traits. Malovrh *et al.* (2015) implemented application in order to obtain percentage of Sattelschwein genome in the population of Krškopolje pig based on the pedigree data available since 1992 only. Pigs born in last years possessed on average more than 75% genome originated from Krškopolje pig breed. Nevertheless, lower percentage (70%) was estimated in the population of Krškopolje pig living breeding animals in the year 2006; three years after the last import.

The aim of this study was to estimate genetic diversity within the Krškopolje pig population as one of the primary tasks in the field of conservation of genetic resources. Altogether, 18 microsatellite loci were analyzed and compared with two major studies of pig breed diversity (Laval et al., 2000; SanCristobal et al., 2006). Genetic structure of Krškopolje pig was performed, compared with Sattelschwein and Slovenian Landrace line 55.

MATERIAL AND METHODS

Altogether, 63 animals of Krškopolje pig, 7 animals of Sattelschwein, and 16 animals of Slovenian Landrace line 55 were analyzed. Samples of ear tissue (Krškopolje pig, Sattelschwein) were collected in 2006, while samples of Slovenian Landrace line 55 were collected in 2009. Eighteen microsatellite loci were analyzed as recommended by D. Milan (INRA) and M. Groenen (WAU) and approved by the FAO-ISAG (FAO, 2004) for the genetic diversity evaluation of European pig breeds. Genomic DNA was isolated from the skin tissue samples by standard phenol-chloroform-isoamyl alcohol (25:24:1) extraction (Ausubel *et al.*, 2000). Fragments were amplified with the PCR reaction, which was carried out in a volume of 10 µl: 0.75 µl of template DNA, 1 x PCR buffer (Fermentas, Vilnius, Lithuania), 1mM $MgCl_2$, 200 µM dNTP, 0.5 U *Taq* DNA polymerase (Fermentas, Vilnius, Lithuania) and 5 pmol of each primer. Primers used for amplification of target sequences were reported in Laval *et al.* (2000). DNA-amplification was performed in a programmable thermocycler GeneAmp® PCR System 9700 (AB Applied Biosystems, USA). Amplification was carried out with initial DNA denaturation (95 °C for 5 min), and following 35 cycles of strand denaturation (95 °C for 1 min), primer annealing at required temperature for each set of primers, and DNA extensions (72 °C for 1 min). Reaction was completed by synthesis of complementary chain.

Amplified fragments were run on a 1.5% agarose gel. The lengths of alleles at each microsatellite locus were analyzed on an ABI 310 automated sequencer. Fluorescently labelled amplified DNA (5 µg) was mixed with formamide (12 µg) and GENESCAN 350 Rox size standard (PE Applied Biosystems, USA).

Statistical Analysis

The calculation of allele frequencies, heterozygosity (observed, expected) and polymorphic information content was performed using GENETIX (Belkhir *et al.*, 2004) and Microsatellite Toolkit v. 3.1 (Park, 2001). Genetic profile based on 11 microsatellite loci was analyzed using the STRUCTURE software 2.3.1 (Pritchard et al., 2000). Number of inferred clusters was assessed in 10 runs, with fitting K from 1 to 6. The burn-in period for all runs was 35000 iterations, and data were collected during the period of 15000 iterations. K method by Evanno et al. (2005) was used to choose the most optimal K-value. Individuals were assigned to populations according to the probability of membership in the cluster, which was characterized based on allele frequencies at each locus.

RESULTS

Genetic diversity was assessed by 18 microsatellite loci within the merged population of Krškopolje pig and Sattelschwein. Imported animals of Sattelschwein were introgressed in the population of Krškopolje pig to prevent inbreeding. The number of alleles per locus in the population differed from one to 11 (Table 1). The average number of alleles per locus was 6.2. Locus SO215 was monomorphic. The maximum number of alleles was found on the locus SO005. Loci SO225, SO951 and SO227 were also considered as poorer information regions. The allele diversity contribution of imported Sattelschwein was minor according to contribution only three additionally alleles on three different microsatellite loci.

Table 1: Average number of alleles per locus (N), effective number of alleles (Ne), expected (He), observed (Ho) and unbiased estimate (Hu) of heterozygosity for merged samples of population of Krškopolje pigs and Sattelschwein

Chromosome	Heterozygosity						
	Locus	N	Ne	He	Hu	Ho	PIC
1	SO155	6	6.00	0.720	0.725	0.738	0.688
2	SW240	9	8.74	0.790	0.795	0.791	0.766
2	SO226	6	7.70	0.666	0.670	0.538	0.605
3	SO002	5	5.00	0.661	0.665	0.687	0.612
4	SO227	4	3.79	0.448	0.450	0.488	0.371
5	SO005	11	10.84	0.868	0.873	0.889	0.854
5	IGF1	9	9.00	0.725	0.730	0.677	0.675
6	SW122	7	6.82	0.757	0.761	0.747	0.719
7	SW632	8	7.86	0.831	0.836	0.858	0.810
8	SO225	4	3.80	0.270	0.271	0.259	0.253
8	SO178	6	6.00	0.799	0.804	0.855	0.769
9	SW911	4	4.00	0.560	0.563	0.560	0.463
10	SO951	4	3.97	0.349	0.351	0.378	0.310
12	SO090	6	6.00	0.712	0.716	0.718	0.659
13	SO215	1	1.00	0.000	0.000	0.000	0.000
14	SW857	7	7.00	0.802	0.807	0.810	0.774
17	SW24	8	7.86	0.785	0.791	0.863	0.755
X	SO218	6	5.99	/	/	/	/
Average		6.2	6.19	0.621	0.625	0.619	

While the average number of alleles is sensitive to the sample size, it was compared to the effective number of alleles, but none of the differences proved to be significant. Heterozygosity was analyzed for all microsatellites, except SO218, which is located on a sex chromosome. Unbiased heterozygosity, which takes into account the number of genotyped animals, was 0.625. Average number of alleles per locus was similar to Schwäbisch-Hällisches population (5.7) and German Landrace (5.6), in which the maximum alleles per loci was found in the study of 11 European pig breeds (Laval *et al.*, 2000). Minimum number of alleles per locus was reported in a local breed Basque (3.22). The observed heterozygosity varied between 0.35 and 0.60. Highly polymorphic marker should have a proportion of heterozygosity of 70% (Ott, 1992). Loci included in our study exceeding this boundary were: SO005, SO178, SW240, SW122, SW857, and SO155.

Harcet *et al.* (2006) performed analysis of diversity of 35 Turopolje pigs, indigenous Croatian pig breed, which has similar history as Krškopolje pig according to unclear origin, bottleneck effect, and the population size. Information of 10 microsatellite loci was used, where one was monomorphic (SO227) and four showed predominance of one allele. The highest number of alleles was four (SW936) and the average number of alleles per locus was 2.4. Observed heterozygosity was 0.306. Low genetic diversity was also found in Black Slavonian pig breed (Bradić *et al.*, 2007). Analysis included 42 animals using eight microsatellite loci. On average, 2.5 alleles were found per locus, while observed heterozygosity was 0.357.

The STRUCTURE analysis based on 11 microsatellite loci included also Slovenian Landrace line 55 as an outgroup beside Krškopolje pigs and Sattelschwein (Figure 1). The most appropriate number of clusters was five. The method assigned Slovenian Landrace line 55 and Sattelschwein individuals into two clearly separated clusters without admixture with Krškopolje pig. However, individuals of Krškopolje pig were assigned into three clusters, identified three subpopulations in accordance with the pedigree relationship among individuals in each subpopulation. Some admixture of Sattelschwein was found in Krškopolje pig, which was in accordance with positive feedbacks of imported animals of Sattelschwein breed before the year 2003.

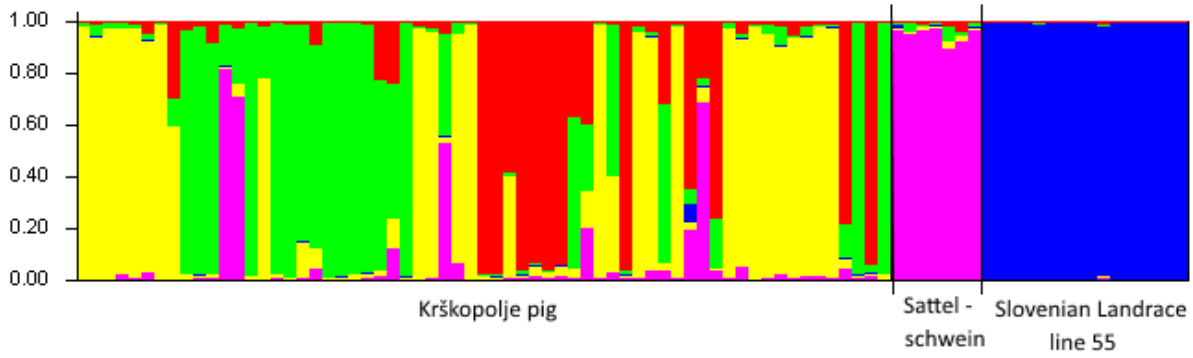

Figure 2: Populations partitioning suggested by STRUCTURE

Detailed tracking of members of three clusters of Krškopolje pig based on the pedigree data indicated that pigs were closely related to limited number of founders, indicated by Malovrh *et al.* (2015).

CONCLUSIONS

Results showed sufficient genetic diversity of the Krškopolje pig population, which could be attributed to the integrity of different breeds before the year 2003, including Sattelschwein pigs, and avoiding mating among relatives. Genetic structure of Krškopolje pig breed formed three subpopulations in accordance with close relatedness with few founders. Individuals of Sattelschwein and Slovenian Landrace line 55 formed their own clusters. Some admixture of Sattelschwein was found in the Krškopolje pig individuals. Results of this study could be affected by sample size and data structure. For indicating migrants and admixed animals in the population of Krškopolje pig, additional breeds should be included.

ACKNOWLEDGMENT

This work was supported by the Program for animal genetic resources conservation, financed by Ministry of Agriculture and the Environment of Slovenia. Molecular genetic analyses were performed in the collaboration with Chair of Genetics, Animal Biotechnology and Immunology at the same department. The authors would like to thank Andreja Opara (Agricultural Institute of Slovenia) for her help in DNA preparation and microsatellite genotypization.

REFERENCES

AČ. 1955. Zakaj bodo zboljšali črnopasasto svinjo. Naša vas, 24: 585

Ausubel F.M., Brent R., Kingston R.E., Moore D.D., Seidman J.G., Smith J.A., Struhl K. 2000. Current protocols. Mo. Vol I. section 2.1.3. New York, John Wiley and sons. Inc.

Belkhir K., Borsa P., Chikhi L., Raufaste N., Bonhomme F. 2004. GENETIX 4.05, logiciel sous Windows TM pour la genetique des populations. Laboratoire Genome, Populations, Interactions, CNRS UMR5171, Universite de Montpellier II, Montpellier, France.

Bradić M., Uremović M., Remović Z., Mioč B., Konjačić M., Luković Z., Safner T. 2007. Microsatellite analysis of the genetic diversity in the Black Slavonian Pig. Acta Veterinaria (Beograd), 57: 209-215.

Evanno G., Regnaut S., Goudet J. 2005. Detecting the number of clusters of individuals using 168 the software STRUCTURE: A simulation study. Molecular Ecology, 14: 2611–2620.

Food and Agriculture Organization (FAO). 2004. Secondary Guidelines for Development of National Farm Animal Genetic Resources Management Plans Measurement of Domestic Animal Diversity: Recommended Microsatellite Markers New Microsatellite Marker Sets — Recommendations of Joint ISAG/ FAO Standing Committee. In: Bradley, D.G., Fries, R., Bumstead, N., Nicholas, F.W., Cothran, Ollivier E.G., Grawford, A.M. (Eds.), Food and Agriculture Organization of the United Nations.

Harcet M., Đikić M., Gamulin V. 2006. Low genetic diversity of the Turopolje pig breed. Food Biotechnol., 44: 105-109.

Laval G., Iannuccellia N., Legault C., Milana D., Groenen M.A.M., Giuffrad E., Anderssond L., Nissene P.H., Jârgensene C.B., Beeckmann P., Geldermann H., Foulley J., Chevaleta C., Ollivier L. 2000. Genetic diversity of eleven European pig breeds. Genet. Sel. Evol. 32, 187–203.

Malovrh Š., Kastelic A., Kovač M. 2015. Rekonstrukcija pasme. In: Kovač M. (ed.), Malovrh Š. (ed.). Krškopoljski prašič - od reje do predelave na domu. 1. edition. Domžale: Biotehniška fakulteta, Oddelek za zootehniko, Enota za prašičerejo: 45-50.

Oblak I. 1938. Svinjereja. Ljubljana, samozaložba: pp 11.

Ott J. 1992. Strategies for characterizing highly polymorphic markers in human gene mapping. American Journal of Human Genetics 51: 283–290.

Park S. D. E. 2001. The Excel microsatellite toolkit. Website 182 http://animalgenomics.ucd.ie/sdepark/ms-toolkit/ [accessed April 2008].

Pritchard J.K., Stephens M., Donnelly P. 2000. Inference of population structure using 188 multilocus genotype data. Genetics, 155: 945–959.

Rohrman V. 1899. Prašičje pleme na Dolenjskem. Kmetovalec, 16: 9–11.

SanCristobal M, Chevalet C, Haley CS, Joosten R, Rattink AP, Harlizius B, Groenen MA, Amigues Y, Boscher MY, Russell G, Law A, Davoli R, Russo V, Désautés C, Alderson L, Fimland E, Bagga M, Delgado JV, Vega-Pla JL, Martinez AM, Ramos M, Glodek P, Meyer JN, Gandini GC, Matassino D, Plastow GS, Siggens KW, Laval G, Archibald AL, Milan D, Hammond K, Cardellino R. 2006. Genetic diversity within and between European pig breeds using microsatellite markers. Anim Genet., 37(3):189-198.

Stefančič A. 1966. Začetek in razvoj veterinarstva na Slovenskem. Ljubljana, SAZU: 21-23.

Šalehar A., Pribožič Z., Švajger G., Bregar D., Štuhec I., Tavčar J. 1992. Krškopoljski prašič. Sodobno kmetijstvo, 25: 326-328.

Švajger G., Bregar D. 1991. Krškopoljski (črnopasasti) prašič = The Krškopolje (white belted black) pig : higher school work. Ljubljana, Univ. v Ljubljani, Biotehniška fakulteta, Oddelek za živinorejo: 53 pp

The quality of products of local breeds

Historical Overview of Slovenian Autochthonous Cika Cattle Breed Production Traits - Milk Yield

Metka Žan Lotrič, Andrej Šalehar and Drago Kompan

University of Ljubljana, Biotechnical Faculty, Department of Animal Science, Groblje 3, SI-1230 Domžale, Slovenia

ABSTRACT

Cika cattle is the only Slovenian autochthonous cattle breed. Different names for breed were used in the past, mostly associated with the place of rearing. So, in Bohinj area the term Bohinj cattle was used. The oldest discovered written source, where the name Bohinj cattle is mentioned, dates back to the year 1846. The original Bohinj cattle had a small body frame, thin bones, consistent forms and it was mainly a dairy type. Up to the sixties of the previous century, Cika cattle was well known as a breed with relatively high milk yield. Expertly organized breeding work for Cika cattle coincides with the foundation of the first Cattle-breeding cooperative, established in 1906. It was the first organisation for milk recording in Cika cattle. Milk recording had great importance in the thirties of the 20th century and in 1934 there were 72% of all purebred cows of Cika cattle included into milk recording. Selection work remained important also at the end of the Second World War, when the buyers of cows took into consideration the criterion of the official data of milk recording. Accepted resolution on the termination of Cika cattle rearing in the sixties of the previous century caused the distinctively decreased number of animals of Cika cattle breed. The decline continued and milk recording of Cika cattle ended in 1971 on state farms and in 1979 on private farms.

Keywords: Cika cattle, autochthonous breed, Slovenia, milk yield, historical sources.

INTRODUCTION

According to the Livestock Breeding Act, accepted in 2002, Cika cattle are classified as one of the Slovenian autochthonous breed, and as such under a special state protection. In the study of historical sources on development of Cika cattle, different names in literature were found, and at least 30 of them are often associated with the place of rearing or coat colour (Bohinj breed, Gorenjska breed, Red Bohinj cattle …). The first record so far that backs to the year 1846 used the naming »*Bohinj cattle*«, where it is written, that Bohinj cattle is a well searched for and desired breed by the breeders from the regions and places like Karst, Vipava, Tolmin and Friuli. A term "Bohinj cattle" symbolized a cow with relatively high milk yield (according to body weight). Encouragement of dairy cows production in Carniola* dates back at least to the first half of the 19th century. In distributing the premiums for the best bulls of a "local" breed the advantage was given to the bull which met the required type traits and was an offspring of a good dairy cow as well (Osnanilo …, 1844). It was stressed in the proclamation that if individual type traits of bulls were very similar, the preference for the premium was given to the bull, which was an offspring of a better dairy cow (Razglas …, 1869). Cika cattle have always been in a close relation with the Alpine dairy farming in the region of Bohinj. Schollmayr (1872) wrote that cattle in Bohinj area were extremely small, often not higher than goat males. A small body frame of these animals had been associated with summer grazing on the highlands of the Alpine Limestone Mountains. Bohinj cattle was considered as a good dairy breed among the prevalent breeds in Carniola* and later in Drava Banovina**. Pirc (1909) wrote: "*There was as much milk as water" say the old Bohinj people and I well believe them. Even in Salzburg area, breeders were competing for Bohinj cows and they came several hours in advance to meet with cattle brokers. They knew that these cows would give them milk in abundance at very modest feed. So they used to sell their low production but well build Pinzgauer cows for high sums of money to their land lords."* Buyers of Bohinj cows came from the Friuli, Carinthia, Salzburg area, Bavaria ... The term "Bohinj cow" itself meant quality and on upper Carniola region they used to say: "*Go to Bohinj to get a cow and go to Poljansko to get a wife*" (Cvenkelj, 1914). An unknown author described milk yield of Bohinj cows as follows: "*Bohinj cows are the best dairy cows bred in our country. They are small in body frame, but very good for dairying ..."* (Bohinjske krave, 1923). Černe (1928) described Bohinj cattle and wrote: »*… you can hardly see anything but a large and a beautiful udder which is worn by a small and gentle animal resembling a deer …*«. Veble (1954) indicates Bohinj cattle as a strong dairy type of cattle, which had been selected by nature and breeders for centuries. Rearing of the so called "cow families" helped to conserve a relatively high milk yield of animals by Bohinj breeders. They did not buy cows; only bulls were bought by the local agricultural cooperative at the fairs of breeding animals. Until the sixties of the previous century, Cika cattle prevailed on upper Carniola region of Slovenia. In the year 1964, a symposium took place in Kranj, where it was accepted, that in the entire region of upper Carniola, Cika cattle need to be replaced by Simmental cattle. There were rare experts who pointed out the specific breeding conditions in Bohinj and they stressed that it is risky to introduce other cattle breeds there.

In accordance with the International Declaration on Biological Diversity (which treats the conservation of biological diversity, including diversity of breeds of domestic animals and plant varieties in agriculture) the remains of Cika cattle were found. This happened at the beginning of 21st century and represented the basis for the establishment of breeding and zootechnical professional work. Today, the conservation is supervised by the Public Service for Farm Animal Genetic Resources Conservation. Due to the social and market changes in agriculture in recent years in Slovenia, many Cika cattle breeders have been advised to breed suckler cows for beef production. Only a few breeders are still using Cika cows for milk production. The objective of the present study is a review of milk yield of Cika cattle, done on the base of historical sources and on the data of milk recording in Cika cattle in the previous century.

MATERIAL AND METHODS

Data for the analysis of milk yield investigation of Cika cattle before the Second World War were obtained from the journal Kmetovalec (Agricultural publication 1884-1944). Data of the average milk yield of Cika cattle after the Second World War were obtained from the reports of milk recording on private and state farms prepared by the Agricultural Institute of Slovenia. Weighted average milk yield and fat content by year were calculated and included into the balance. We used the method of least square means by which we assessed the impact of year as linear regression of weighted averages with respect to the year. Data were analysed with the software package SAS (SAS/STAT, 1990).

RESULTS

MILK RECORDING DEVELOPMENT IN CIKA CATTLE

The first livestock cooperative in Carniola* was established in 1906 in Selce, a small town situated above Škofja Loka by a provincial dairy and livestock supervisor for Ljubljana region - Rado Legvart. He named the first livestock cooperative after Cika cattle breed. He also prepared the selection work rules and created the herdbook. The selection work in animal husbandry was cut off by the First World War. After the war it was re-established in some animal husbandry organizations. (Poročilo o kontroli …, 1956).

MILK YIELD OF CIKA CATTLE IN DRAVA BANOVINA

Milk recording in Drava Banovina was mandatory for all purebred cows included in the herdbook. Milk recording results for Gorenjska Cika cattle in Gorenjska district during the period 1930-1934 are shown in Table 1.

Table 1: Results of milk recording for Gorenjska Cika cattle in Gorenjska breed district during 1930-1934 (Wenko, 1933, 1934, 1935)

Year	Selection units for milk recording		No. of cows included in milk recording	% of cows in milk recording /no. of cows in herdbook	Milk yield (l)				Milk yield as breed average (l)
	No.	No. of cows in herdbook			Max.	Min.	Average of particular unit Max.	Min.	
1930			43						2.28
1931	17	611	119	19 %	4.89	1.15	2.80	1.81	2.19
1932	25	844	300	36 %	3.97	1.02	2.52	1.80	2.15
1933	18	629	231	52 %	3.96	442	2.55	1.45	2.07
1934	24	1.048	539	72 %	3.94	769	2.56	1.69	2.07

Wenko (1933) observed a strong extension work in 1931 as compared to 1930. Gorenjska Cika cattle achieved the best milk yield among all breeds in 1930, while in 1931 it was in the second place. The number of cows included in milk recording in 1932 increased by 80% in comparison to the year 1931 (Wenko, 1934). The largest increase in the Drava Banovina reached Cika cattle (152%). In 1932, Gorenjska Cika cattle was in the third place among all breeds included to milk recording. The percentage of recorded purebred cows included into herdbook in the whole Drava Banovina increased to 45% in 1932 in comparison to 1931. However, there were still more than half of the cows unrecorded. In 1932, Gorenjska Cika with an average milk yield of 2.150 litres was in the second place among dairy breeds. The proportion of cows of Gorenjska Cika cattle involved in milk recording increased in individual years and in 1934 there were 72% of all purebred cows of Gorenjska Cika cattle included to milk recording. Table 2 provides the average milk yield of purebred cows per breed in 1939.

Table 2: Average milk yield of breeding cows per breed in 1939 (Ferčej, 1951)

Breed	No. of cows	Average milk yield (l)	No. of cows with milk yield (l)	
			2.000-3.000	above 3.000
Gorenjska Pinzgauer cattle	731	2.177	447	50
Simmental cattle	1.012	2.177	458	121
Brown cattle	991	2.148	500	119
White Slovenian cattle	413	2.176	238	33
Murboden cattle	486	1.948	173	16

MILK YIELD OF CIKA CATTLE DURING THE SECOND WORLD WAR

Ferčej (1947) writes that Bohinj cows were known as good dairy cows and breeders from other places liked to buy them for this reason. According to the reports of the Association for selection work organization for Pinzgauer cattle breed in Kranj, the average milk yield in 1940 including 738 purebred cows was 2.177 litres. Of these cows 61% achieved 2.000 - 3.000 litres and about 6% of the cows over 3.000 litres of milk. The best cow gave an average 4.350 litres of milk per year. Based on these data Ferčej (1947) concludes that Gorenjska cows are relatively good dairy cows considering their weight, especially the Bohinj cows. The author continues that good Bohinj dairy cows produced more milk per year, about six times their body weight.

MILK YIELD OF COWS IN BOHINJ AREA AFTER THE SECOND WORLD WAR

After the Second World War, milk production of cows in the Bohinj area was low, as a result of a sharp reduction in number of cows and other cattle categories in the years of war (Veble, 1954). Ferčej (1951) is convinced that milk yield of these cows could be further increased, while lower milk yield of purebred cows the author attributes to the consequences of war. Veble (1954) reports that dairy cows in Bohinj in 1957 had the average annual milk yield of 2.400 l with 4.02% fat, and at the summer Alpine grazing they used to produce the average of 3 to 3.5 litres of milk per day.

MILK RECORDING OF COWS IN SLOVENIA AFTER THE SECOND WORLD WAR

Milk recording was organised and led by the Republic's Animal Husbandry Committee of the Main Cooperative Association, while Agricultural Institute of Slovenia took charge of the professional work (Šef, 1980). In addition to the general tendency to increase milk yield the rapid progress in milk recording was strongly influenced also by the growing demand of breeding animals and by the recognition of the principle that a higher price reaches only that breeding animal, which has a clear information on its milk recording. Breeders were increasingly demanding quality animals with the reliable official data of their production (Poročilo …, 1956). The results of milk recording for Cika cattle on state farms in the period from 1960 to 1971 are shown in Table 3, while Table 4 shows the results of milk recording by years of Cika cattle on private farms from 1960 to 1979.

Table 3: Cika cattle milk recording results on state farms (1960-1971) (Šef, 1980)

Year	No. of milk recorded cows	Milk yield (l)	Fat content (%)
1960	44	2.615	3.79
1962	11	2.729	3.98
1964	404	2.671	3.77
1966	502	2.878	3.90
1968	62	2.414	3.75
1971	13	2.223	3.81

Table 4: Cika cattle milk recording results on private farms 1960 - 1979 (Šef, 1980)

Year	No. of milk recorded cows	Milk yield (l)	Fat content (%)
1960	114	2.684	3.92
1966	762	2.298	3.87
1967	325	2.395	3.86
1971	197	2.852	3.89
1972/1973	206	2.999	3.88
1976	149	3.066	3.62
1979	108	3.226	3.88

In 1960, there were 44 cows of Cika cattle included in milk recording in regard to the state farms (Table 3) and 114 cows in regard to the private farms (Table 4). In 1966, the number of cows included in milk recording on private farms increased almost six times in comparison to 1960. In 1967 the number of recorded cows halved in comparison to 1966. In the following years their number has slowly declined. Cows of Cika cattle were again included into milk recording in 2008, mainly belonging to breeders who were engaged in market milk production. Weighted average of Cika cattle milk yield and fat content by year is shown in Figure 1.

Figure 1: Weighted average of Cika cattle milk yield and fat content by year

The produced milk yield in Cika cattle breed has been annually increased by 19.7 ± 2.0 l (Figure 1). The increasing trend of milk yield in the period 1930 - 1934 (1939) and 1955 - 1979 was statistically significant ($p < 0.0001$). Milk fat content in the period 1955 - 1979 decreased 0.004 ± 0.002 %. The trend of milk fat content was not statistically significant ($p = 0.0856$).

CONCLUSION

The promotion of dairy cows rearing on today's territory of Slovenia was encouraged already in the first half of the 19th century. Dam`s milk yield was the most important criteria in giving premiums to their male offspring (bulls). Cika (Bohinj) cattle breed was a synonym for an excellent dairy cow, which gave the most reliable yield at very modest breeding conditions. Relatively high milk yield of Bohinj cows was appreciated also outside of Bohinj area. Rearing of Cika cattle breed was directed to milk production up to the sixties of the previous century. Milk yield of Cika cattle was comparable to the other breeds. Later on, the decisions on upgrading Cika cattle with Simmental breed were accepted. For almost 40 years the breed was without selection and special thanks should be given to the breeders to conserve Cika cattle in such unfavourable conditions for rearing autochthonous breeds. After the year 2000 the zootechnical work in Cika cattle was restored. For the continuation of originality (original type) of Cika cattle it is necessary to conserve the dairy type of Cika cattle, which is in accordance with breeding work for this breed in the past. This also requires the accepted and approved breeding program, indicating Cika cattle as a dual purpose breed with more emphasis on milk production. Recently, an importance of conservation of livestock biodiversity (especially autochthonous breeds), sustainability, and organic food production in the global, regional and local level is growing. In Slovenia, all these aspects are fulfilled by rearing methods of Cika cattle, which are in accordance with the traditional technology and the low input production systems. These are in close connection with the Alpine mountain grazing. Therefore, it should be important that the government encourages and supports breeders of Cika cattle to the milk processing into dairy products, which are of exceptional quality and highly appreciated. Cika cattle is included into the Slovenian natural and cultural heritage and further professional work on this autochthonous breed should be focused on creating a niche market for dairy products and at the same time for their trademark development. Brand recognition, local supply and extremely tasty products could certainly represent the story of success regarding the Slovenian autochthonous breed, which was nearly lost.

*Carniola - a historical region that comprised parts of present-day Slovenia and was abolished in 1918.

**The Drava Banovina or Drava Banate (Slovene: Dravska banovina) was a province (banovina) of the Kingdom of Yugoslavia between 1929 and 1941. This province consisted of most of the present-day Slovenia and was named after the Drava river. The capital city of the Drava Banovina was Ljubljana.

REFERENCES

Bohinjske krave. 1923. Kmetovalec, 40, 65-66

Cvenkelj A. 1914. Rešimo bohinjsko govejo pasmo. Domoljub - Naš kmečki dom, 51, 10-13

Černe F. 1928. Živinoreja. Celje, Družba sv. Mohorja, 322 p.

Ferčej J. 1947. Gorenjsko pincgavsko govedo. Stočarstvo, 6: 246-254

Ferčej J. 1951. Kakovost naše goveje živine. Živinorejec, 2, 36-44

Legvart R. 1910. Živinoreja. In: Zibar J. (ed.): Govedoreja. Ljubljana: 102-143.

Osnanilo zesarskiga kraljeviga ilirskiga poglavarstva v Ljubljani. 1844. Ljubljana, (SI AS 1079 Zbirka normalij, šk. 17), N. 3878.

Pirc G. 1909. Bohinjska goveja pasma. Kmetovalec, 26, 204-205

Poročilo o kontroli proizvodnosti krav v LR Sloveniji za leto 1955. 1956. Kmetijski institut Slovenije, Ljubljana.

Razglas, kako se bodo državne premije za zboljšanje goveje živine na Kranjskem delile. 1869. Oglasnik (Priloga kmetijskih in rokodelskih novic), 4, K 8.1.

SAS/STAT, User's Guide. 1990. Version 6. Cary, NC, SAS Institute Inc.

Schollmayr F. 1872. Die Rindviehracen von Krain nach den Erhebungen in Jahre 1872.

Šalehar A. 2009. Prispevki k bibliografiji: Zgodovinski viri o slovenskih avtohtonih in tradicionalnih pasmah domačih živali - do leta 1945. http://www.dlib.si/?URN=URN:NBN:SI:DOC-ZTF15AIY

Šef M. 1980. Rezultati kontrole proizvodnosti krav v letu 1979. Ljubljana, Kmetijski inštitut Slovenije: 64 p.

Veble F. 1954. Naše goveje pasme. Ljubljana:162-166

Wenko B. 1933. Koliko molzejo naše krave? Kmetovalec, 50, 29-30

Wenko B. 1934. Koliko molzejo naše krave? Kmetovalec, 51, 198-199

Wenko B. 1935. Koliko molzejo naše krave? Kmetovalec, 52, 135-137

Žan Lotrič M. 2012. Development of Cika cattle breed and Alpine dairy farming. PhD Diss. Domžale, Slovenia: University of Ljubljana 372 p. Available from: University of Ljubljana, Biotechnical Faculty

The Krainer Steinschaf - an old breed and a new chance

Beate Berger[1], Barbara Soritz[2]

[1] Institute of Organic Farming and Biodiversity of Farm Animals, Austr. 10, 4601 Thalheim, Austria
[2] Verein der Krainer Steinschafzüchter Alpen Adria, Unterfresen 58, 8541 Schwanberg, Austria

ABSTRACT

The Krainer Steinschaf was developed in the region of Southern Carinthia, Northern Slovenia and North-Eastern Italy as a dairy breed. In 1994 the Austrian herdbook registered only 7 rams and 35 ewes. Since then the population has grown to 107 herds with 169 rams and 2695 ewes (2013). The controlled mating is successful; inbreeding rate per generation is 0.27%. The effective population size is 185.2. More than 80% of the ewes are kept on organic farms. From 2008 to 2013 the Krainer Steinschaf took part in a LEADER project to develop and market an organic brand of lamb meat. "Jungschaf vom Krainer Steinschaf" is a co-operation between the breeder organisation "Verein zur Erhaltung des Krainer Steinschafes" and the largest Austrian food retailer. Only herdbook breeders in the conservation-breeding program can take part in the marketing project. The lambs are fattened on roughage without concentrates. Farmers get a bonus for the lambs as well as the official support for the breeding program. In 2014, the meat of more than 800 lambs was sold as a premium product in Styrian and Burgenland.

Keywords: Sheep, rare breeds, conservation, product marketing, organic farming

INTRODUCTION

The Krainer Steinschaf, called Bovska sheep in Slovenia or Plezzana sheep in Italy, was developed as a dairy breed as early as the 17th century in the region of today's Southern Styria, Carinthia, Slovenia and North-Eastern Italy. The breed descends from the Medieval Zaupelschaf, a small but hardy sheep with a shaggy coat and high non-seasonal fertility. Contrarily to other Alpine sheep breeds no Bergamaska introgression was introduced into the Krainer Steinschaf (Fischerleitner, 2002).

The sheep are small framed, adult ewes weigh 55 to 60 kg in maximum. The animals may carry horns but most are polled. All colours are permitted, from white to black. Pied animals are not discriminated against, as pied lambskins find a ready market. The wool is coarse carpet quality; wool production is rather low about 2.5 to 3.5 kg per year. Remarkable are the very hard hooves and the high resistance to foot rot in the breed. The animals can stand harsh Alpine climate with little shelter. Traditionally they are milked, and in Slovenia the milk is used for cheese specialities (Cividini *et al.*, 2012).

The genetic bottleneck at the end of the 20th century was severe. As the Austrian population was too small to survive on its own 30 breeding, animals were imported from Slovenia in 1988. A herdbook was founded in 1990 by the Carinthian Sheep Breeding Organisation (Berger and Fischerleitner, 2008). To further broaden the genetic base in 1992 three rams were imported from Slovenia as well. Since then the population has developed steadily without new imports from Slovenia or Italy (EFABIS, 2015). As a residual population it can be distinguished genetically from other phenotypically similar Zaupelschaf-related breeds like the Waldschaf or the Alpines Steinschaf (Baumung and Sölkner, 2003).

The aim of the study was to show the development of the conservation strategy of a highly endangered population from re-stocking with regard to the maintenance of the genetic diversity within the breed to the sustainable use in a high quality production program.

MATERIAL AND METHODS

Population data are available from 1994 and 2001 to 2013 in the EFABIS (Table 1). Inbreeding rate (Δf) from 2002 to 2013 was calculated according to the algorithm installed in the Austrian central registry database SCHAZI. Effective population size (N_e) was calculated according to Falconer (1996).

The production guidelines of the marketing project were developed in a LEADER project 2007 – 2013. LEADER is a part of the core area 4 of the European ELER program 2007 - 2013. Only organic farms can join the marketing scheme. They must be members of the breeding organisation and breed according to the gene conservation program. Regulations for raising of the lambs contain compulsory grazing of lambs together with their mothers with no additional feeding as long as the vegetation permits. Only roughage may be fed additionally in late autumn, winter and early spring.

RESULTS AND DISCUSSION

Conservation programs

The first conservation program was already part of the Austrian Agri-Environmental Program 1995 to 2000 and aimed at registration of all purebred animals in the herdbook. When in 1998 the breeding organisation Verein der Krainer Steinschafzüchter Alpen Adria was founded the Austrian herdbook was closed (Berger and Fischerleitner, 2008).

In the second program from 2001 to 2006 the breed was characterized genetically using 25 markers (Baumung and Sölkner, 2002) and confirmed as a separate breed. A system of planned mating and monitoring within the Austrian gene conservation program was introduced to re-build the breeding population while maintaining genetic diversity (Fischerleitner, 2002). Since 2002 population size and population genetics parameters are monitored yearly by Austrian Association for Rare Endangered Breeds (ÖNGENE). As is shown in Table 1 due to the successful support from the conservation program the breeding population increased steadily to almost 2700 ewes in 2013.

Table 1 Population data (EFABIS, 2015)

	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Austria													
rams	22	68	46	87	56	43	65	108	121	132	148	154	169
ewes	229	354	311	441	420	407	603	1041	1549	1928	2388	2719	2695
Slovenia													
rams			83	83	95	73	69	66	78	79	148	156	158
ewes			1732	1865	1813	1758	1868	1866	1862	1934	2556	2638	2529
Italy													
rams		15	12										7
ewes		79	61										103

According to Cividini *et al.* (2012) an equally numerous breeding population is present in Slovenia but due to veterinary regulations in Austria concerning MAEDI/VISNA currently no exchange of breeding animals is possible. Considering the stable Δf and the increasing N_e in the Austrian population (Table 2) the genetic diversity in the growing Austrian population seems to be well maintained. Semen of 18 founder rams is conserved in Austrian Gene Bank for Farm Animals in the case of emergencies. The third conservation program started in 2007 and finished in 2014. The main tasks in the program were characterization of production traits and development and marketing of products of rare breeds.

Table 2 Rate of inbreeding and effective population size in Austria

	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Δf	1.9	0.8	1.5	0.7	0.6	-0.7	0.5	0.4		0.3	0.3	0.2	0.3
N_e	26.9	61.7	33.8	67.6	86.2		111.1	113.6		172.4	156.3	263.2	185.2

Δf = inbreeding rate, N_e = effective population size

Marketing program

The Verein der Krainer Steinschafzüchter Alpen Adria took part in a Styrian LEADER project. A special marketing organisation was founded (Verein zur Erhaltung des Krainer Steinschafes) to ensure that only members of the marketing organisation can sell lambs into the quality scheme. According to the production guidelines developed in the project farms must be organic. They must be members of the breeding organisation and breed according to the gene conservation program. Regulations for raising the lambs contain compulsory extensive grazing together with their mothers with no additional feeding as long as the vegetation permits. Extensive grassland that would otherwise lie fallow or be given over to shrubs is used for production. Only roughage may be fed additionally in late autumn, winter and early spring, silage is restricted to max. 40% of the ration. All male lambs are weaned at the age of three months and raised in separate herds. Slaughter age is from 5 to 6 months.

The resulting carcass is lighter than the carcass of intensively fed lambs from commercial breeds or crossbreds but very lean and has no undesirable mutton odour. The meat is of intensive rose colour, very tender and juicy. Customers are ready to pay premium prices for high quality that is produced organically. Although the LEADER project ended in 2013 the marketing scheme continues to grow, 800 slaughter lambs were sold in 2014.

CONCLUSIONS

After the successful re-establishment of breeding populations of rare breeds the marketing of new and high quality products is an important contribution to the further promotion of a breed. The Austrian consumer is ready to pay premium prices for special products. This is even more the case if background information like high animal welfare standards, organic production and no use of concentrates in the program are transported with the product. The successful management of extensive grassland with traditional breeds can be considered an added bonus in the program.

REFERENCES

Baumung R., Sölkner, J., 2002. Genetische Differenzierung von Schafrassen im Ostalpenraum. Final report, Division of Livestock Sciences, University of Natural Resources, Vienna, Austria, 2003, p. 10.

Berger B., Fischerleitner F., 2008. Die seltenen erhaltungswürdigen Schafrassen Österreichs. Austrian Association for Rare Endangered Breeds, 2nd ed. 2013, p. 7.

Cividini A., Ramljak J., Berger B., 2012. Sub-regional and transboundary challenges and opportunities for gene banking (Slovenia, Croatia, Austria). ERFP Working Group Ex Situ Conservation Workshop, Zagreb, 23.05.2012

EFABIS, 2015. available at http://efabis.raumberg-gumpenstein.at

Falconer D.S., Mc Key T., 1996. Introduction to quantitative genetics. Ed. Longman, London, UK, p. 464.

Fischerleitner F., 2002. Die gefährdeten Nutztierrassen Österreichs. Austrian Association for Rare Endangered Breeds 2002, p. 49 – 51.

Meat quality of autochthonous Sjenica Zackel sheep - Basis for sustainable production of genetic resource on the Sjenica-Pester plateau

Zsolt Becskei[1], Mila Savić[1], Aleksandar Cojkić[1] Blagoje Dimitrijević[2], Mladen Rašeta[3], Nataša Kilibarda[4] And Mensur Vegara[5]

[1]Department for Animal Breeding and Genetics, Faculty of Veterinary Medicine, University of Belgrade, Serbia,
[2]Clinic for Ruminants and Pigs, Faculty of Veterinary Medicine, University of Belgrade, Serbia,
[3]Institute of Meat Hygiene and Technology, Belgrade, Serbia,
[4]Veterinary Specialist Institute „Subotica“, Subotica, Serbia,
[5]Department of International Environment and Development Studies, Norwegian University of Life Sciences NMBU, Ås, Norway

ABSTRACT

Sjenica sheep is the largest type of autochthonous Zackel sheep reared in Serbia. It is well adapted to harsh climatic and environmental conditions, which exist on the High Nature Value Sjenica-Pester plateau of the mountain regions of south-west Serbia. The Sjenica sheep is considered as vulnerable due to increasing dilution of the populations under the influence of meliorators, such as Wurttemberg sheep. Therefore, it is necessary to undertake protective measures, such as in vivo conservation, with special attention to advanced phenotypic characterization of adaptive and productive breed traits, as a strategy for a rational utilization of sheep resources. The objective of the study was to perform and evaluate the advanced phenotypic characterization of Sjenica sheep, especially its productive potential and meat quality traits. In this paper the evaluation of sensory characteristics (odour intensity, flavour intensity, flavour quality and overall acceptability) and the fatty acid composition of meat (*M. longissimus dorsi)* samples of Sjenica sheep were done. The results indicated desirable sensory characteristics of tested lamb meat, with high overall acceptability score (6.12 ± 0.25). Furthermore, favourable fatty acid composition has been found in the meat samples of Sjenica sheep. The CLA content was at a high level (4.12 ± 0.48), also the n-6:n-3 ratio was desirable (1.88 ± 0.32), which can partly be explained by the influence of the traditional habitat, such as specific floristic composition in which animals are reared.

Keywords: Zackel sheep, autochthonous, meat quality, characterization.

INTRODUCTION

The knowledge of the importance of animal genetic resources and the management of these resources are very important objectives of current livestock production. Bad influence of climate changes and occurrence of new diseases in sheep make the conservation of locally adapted sheep breeds extremely important (FAO, 2010; Hoffman, 2010). Autochthonous locally adapted domestic animals gained resistance and adaptability through the evolution of breeds in their given ecosystems (Hiemstra 2010). Keeping this fact in mind, the Faculty of Veterinary Medicine – Belgrade, for last decade undertakes a permanent characterisation and strategy for rational use of animal genetic resources (Savić et al., 2011). The most important autochthonous sheep breed in Serbia is Zackel sheep. This breed has been developed under modest biogeographic conditions and exhibits a high degree of adaptation to environmental conditions, such as climate and specific phitocenotic conditions. Zackel sheep is triple purpose (meat, lamb, wool) low production breed, with prominent phenotype diversity (Becskei, 2011).

Sjenica sheep is locally adapted, autochthonous Zackel sheep type, inhabiting the mountain regions of south-western Serbia, traditionally reared in Sjenica-Pester plateau (900 -1400 m altitude). Sjenica-Pester plateau belongs to High Nature Value region and is well known on its rich biodiversity with favourable floristical composition of the pastures (47300 ha) and meadows (26200 ha). The region has a specific microclimate with harsh and long winters, often with low temperatures up to -37ºC. In addition to temperature, one of the important factors of climate influence on the vegetation is the amount of rainfall and its distribution throughout the year as well as relative humidity. The annual rainfall precipitation is as much as 700 mm per square meters per year.

According to the FAO classification Sjenica sheep is not on the Endangered breed list (FAODAD-IS, 2012). However, due to the popular trend of crossbreeding with exotic breeds such as Wurttemberg and Ille de France, population of Sjenica sheep is vulnerable. The total number of purebred Sjenica sheep is constantly decreasing. According to the results, autochthonous Sjenica sheep have an adaptive and selective advantage and represents a breed of choice for sustainable management in hilly-mountainous region. Traditional meat and milk products (Sjenica lamb, Sjenica cheese, etc.) contribute to the promotion of the region and development of rural areas, thus directly increasing the value of Sjenica breed (Savić et al., 2011).

The objective of the study was to perform and evaluate the advanced phenotypic characterization of Sjenica Zackel sheep, especially its productive potentials regarding to meat-quality traits.

MATERIAL AND METHODS

The survey was carried out on 12 autochthonous Sjenica sheep lambs. The lambs were produced in an extensive, sustainable management system in the region of the Sjenica-Pester plateau. Their diet was based on grazing on native pastures. The lambs of both sexes were slaughtered at the age of 90-100 days, with mean weight of 26.50 ± 1.80 kg. The lamb carcasses were refrigerated at +4ºC for 24 h before sampling for analysis. The next day, muscle samples from cold carcasses were taken. Two slices of *M. longissimus dorsi* (at the first lumbar vertebra) were sampled for sensory and intramuscular fatty acid analysis.

The selection and training of the evaluators were conducted in accordance with ISO 8586-2:2012 (Sensor Features - General guidance for the selection, training and monitoring of assessors; Part 2: Sensory assessors (experts). Quantitative descriptive analysis (evaluation of the acceptability-odour) was performed according to ISO 6564:1985, the structural intensity scale / eligibility of seven points, with the score of 7 being the maximum intensity / eligibility, and score of less than 3.5 marked the product as unacceptable. The odour intensity, flavour intensity, flavour quality and overall acceptability were scored. Colour and odour of the meat samples were analysed before thermal treatment. Before cooking the fat was removed from the *M. longissimus dorsi*. The samples of *M. longissimus dorsi* were grilled (70ºC internal temperature) and cut into thin slices. Sensory analysis was done by an eight member trained taste panel professional commission.

For fatty acid composition of the *M. longissimus dorsi* samples stored as described above were used immediately after thawing. Subcutaneous fat was removed over the *M. longissimus dorsi*. Analysis was performed in accordance with ISO 5508 and ISO 5509 norms. For the determination of fatty acids, total lipids were extracted by the method of rapid extraction with a solvent mixture of n-hexane and iso-propanol (60:40 v/v) on Dionex ASE 200 apparatus. The obtained extracts were evaporated under a stream of nitrogen (Dionex SE 500 apparatus), at 50°C until a dry lipid residue was obtained. The extracted lipid was used for the determination of fatty acids. Fatty acid methyl esters were prepared by trans-esterification with trimethylsulfonium hydroxide, according to the method EN ISO 5509:2007. Methyl esters were separated on a HP-88 column (column length 100 m, inner diameter 0.25 mm, film thickness 0.20 μm, J & W Scientifi c, USA) by capillary gas chromatography with a flame ionization detector (Shimadzu 2010, Kyoto, Japan). The injector temperature was 250°C and the detector temperature was set at 280°C. The carrier gas was nitrogen with a flow rate of 1.33 ml/min and a split ratio of 1:50. The injected volume was 1 μl, and the total run time 50.5 min. Fatty acid methyl esters were identified based on retention time compared to the retention times of a mixture of fatty acid methyl esters present in the Supelco Component 37 FAME mix standard (Supelco, Bellefonte, USA).

RESULTS

Some of the meat quality characteristics (*M. longissimus dorsi*) were evaluated for 12 Sjenica sheep lambs. All the tested meat samples had a fine structure, high juiciness and tenderness. Very favourable meat aroma and overall acceptability were detected in all samples. Table 1 summarises the sensory characteristics of tested lamb meat samples.

The other research goal was to analyse the fatty acid content of Sjenica lamb meat samples. Special attention was paid on conjugated linoleic acid (CLA) content and polyunsaturated fatty acid n-6:n-3 ratio, as it is well known that these have positive effects on human health. The result shows desirable fatty acid composition of saturated and unsaturated fatty acids. The polyunsaturated fatty acid content (∑ PUFA) was 3.40 ± 0.56 with favourable ratio of n–6:n−3 (1.88 ± 0.32) The detected CLA content is high (4.49 ± 0.59) Data summary on the fatty acid content (% by weight of total fatty acids) are presented in Table 2.

Table 1. Sensory characteristics of Sjenica lamb meat

Scores of sensory characteristics of Sjenica lamb meat M ± SD					
Colour	**Odour**	**Juiciness**	**Tenderness**	**Odour and Flavour (Aroma)**	**Overall acceptability**
5.96 ± 0.34	5.78 ± 0.32	5.89 ± 0.32	5.86 ± 0.28	6.12 ± 0.23	6.12 ± 0.25

M – mean value; SD – standard deviation.

Table 2. Fatty acid composition (% by weight of total fatty acids) of Sjenica lamb meat samples (*M. longissimus dorsi*)

Fatty acids	**M ± SD**
C14:0	2.83 ± 0.24
C15:0	0.41 ± 0.06
C16:0	24.35 ± 2.40
C16:1	1.55 ± 0.24
C17:0	1.25 ± 0.28
C18:0	25.92 ± 3.58
C18:1 cis9	35.81 ± 2.53
C18:2 n-6	2.46 ± 0.24
C18:3 n-3	1.11 ± 0.22
C20:0	0.23 ± 0.01
C20:3 n-6	0.02 ± 0.01
C20:5 n-3	0.02 ± 0.01
C22:1 + C20:4	0.11 ± 0.02
22:5 n-3	0.16 ± 0.05
Σ SFA (Saturated fatty acids)	53.16 ± 2.96
Σ MUFA (Monounsaturated fatty acids)	36.98 ± 2.82
Σ PUFA (Polyunsaturated fatty accids)	3.72 ± 0.56
CLA	4.12 ± 0.48
Σ n-3 PUFA	1.29 ± 0.36
Σ n-6 PUFA	2.43 ± 0.22
n-6/n-3 ratio	1.88 ± 0.32

M – mean value; SD – standard deviation.

DISCUSSION

Autochthonous types of Zackel sheep in Serbia are considered to be severely endangered. A major route for endangering autochthonous breeds in Serbia has been uncontrolled cross-breeding and crossing with highly selected exotics breeds like Wurttemberg and Ile de France. Consequently, certain local breeds are already extinct while other populations are endangered and consistently declining in number. Sjenica sheep is the biggest strain of Zackel breed, traditionally grown in Sjenica-Pester plateau, fully adapted to the challenges of the environment (Jovanović *et al.*, 2009).

In the recent years there is a growing interest for the consumption of animal products with a favourable content of fatty acids with a positive effect on human health. Great attention has been laid on the relative proportion of n-6 and n-3 fatty acids, which can be a preventive factor for cardiovascular diseases, certain malignant and autoimmune diseases, such as lupus, rheumatoid arthritis, etc (Popović et al., 2011; Schmid et al., 2006). The interest in investigating lamb meat characteristics has been increasing, considering that lamb meat used in the weaning diet of children is presumed to have a lower allergenicity than other red meat (Nudda et al., 2011). The established results are in accordance with a number of studies. They have confirmed that interaction between a breed and nutritional regimens with specific grass composition of pastures in the traditional habitat has a large impact on odour and flavour of lamb meat (Demirel et al., 2006; Ramirez-Retamal et al., 2014).

The results of sensory analysis of tested meat samples classified Sjenica sheep as a breed with very attractive sensory characteristics. Botanical analysis of plants from High Nature Value pastures and meadows of Pester-plateau shows a high biodiversity. The most frequent herbs are from the families of grasses 48.4%, legumes 9.6% and other herbs 42.0%. Floristic analysis proves that grasses and legumes of high and mild quality are predominantly present. A large number of grass species were detected. From the family of *Poacea: Anthoxanthum odoratum, Arrhenatherum elatius, Briza media, Danthona calycina, Bromus raceomus, Agrostis vulgaris, Dactylis glomerata, Festuca rubra, Festuca ovina, Phleum pretense*. The family of *Fabacea* were mainly presented by *Genista saggittalis, Lathyrus latifolius, Lotus corniculatus, Trifolium pretense, Vicia cracca, Trifolium alpense, Trifolium alpestre, Trifolium panonicum, Trifolium montanum* (Vučković et al., 2004, 2010). The specific botanical composition and high diversity of favourable plants in grasslands of pastures and meadows in Sjenica-pester plateau provides specific, high quality lamb meat products.

The results of this researches are in accordance with a number of studies, where traditional habitat conditions have an influence on the fatty acid composition and flavour of lamb meat (Demirel et al., 2006; Ramirez-Retamal et al., 2014). Favourable fatty acid profile and sensory characteristics were obtained in Sjenica sheep meat. This results confirm the favourable content of CLA (4.12 ± 0.48) and of n-6:n-3 ratio (1.88 ± 0.32). This knowledge contributes to the advanced phenotypic characterization of Sjenica sheep; it helps determination of the value of locally adapted Sjenica breed. Furthermore, it facilitates realistic decision making for the promotion of sustainable use of Sjenica sheep. The favorable fatty acid profile, important for human health and especially for infant and children nutrition, raises the interest for sustainable production of Sjenica sheep. By recognizing that locally adapted animal breeds gained genetic resistance and adaptability through the evolutionary process, breeding strategies in sustainable farming practices today are far more attuned to the need for preserving and utilizing Sjenica sheep as a valuable genetic resource.

CONCLUSIONS

For achieving better productive results of Sjenica sheep, an integrated approach is necessary. The approach must contain all aspects of sheep keeping, feeding, breeding and disease prevention, as well as pasture management. Investigations of specific characteristics of autochthonous sheep breeds, especially advanced phenotype characterization of the productive potentials and specific product characteristics are important topics for a sustainable conservation strategy.

ACKNOWLEDGEMENTS

This study was supported the Ministry of Education and Science of Republic of Serbia, Grant No. TR 31085 and the Norwegian Programme in Higher Education, Research and Development in the Western Balkans 2010-2014.HERD/Agriculture Project 09/1548, 332160 UA.

REFERENCES

Becskei Z., 2011, Primena in situ konzervacije animalnih genetičkih resursa u stočarstvu, specijalistički rad, Fakultet veterinarske medicine Univerziteta u Beogradu, Beograd.

Demirel G., Ozpinar H., Nazil B., Keser O., 2006 : Fatty acids of lamb meat from two breeds fed different forage: concentrate ratio. Meat Sci 72, 229-235.

FAO, 2010, Breeding strategies for sustainable management of animal genetic resources. FAO Animal Production and Health Guidelines No.3.

FAODAD- IS, 2012, Domestic Animal Diversity Information System.

Hiemstra S.J., 2010, Towards (self) sustainability of local cattle breeds in Europe, In: Proceedings Book of the 61st EAAP Annual Meeting, Heraclion Crete, Greece.

Hoffmann I., 2010, Climate change and the characterization, breeding and conservation of animal genetic resources. Anim Genet 41, 32-46.

Nudda A., McGuire M.K., Battacone G., Manca M.G., Boe R., Pulina G., 2011, Documentation of fatty acid profiles in lamb meat and lamb-based infant foods. J Food Sci 76, 43-47.

Popović-Vranješ A., Savić M., Pejanović R., Jovanović S., Krajinović G., 2011, The effect of organic milk production on certain milk quality parameters. Acta Vet-Beograd 61, 415-421.

Ramírez-Retamal J., Molares R., Martinez E., de la Barra R., 2014, Effect of the type of pasture on the meat characteristics of Chilote lambs. Food Nutrit Sci 5, 635-644.

Schmid A., Collomb M., Sieber R., Bee G., 2006, Conjugated linoleic acid in meat and meat products. Meat Sci 73, 29-41.

Vučkovic S., Simic A., Ćupina B., Stojanovic I., Stanisavljevic A., 2004, Uticaj đubrenja azotom na produktivnost pašnjaka Cynosuretum cristati na Sjeničko – pešterskoj visoravni. Acta Agriculture Serbica 4 (17), 279-87.

Vučković S., Simić A., Ćupina B., Krstić Đ., Duronić G., 2010, Effect of mineral fertilization on yield of Agrostidetum vulgaris – type meadows in mountainous grasslands in Serbia. Biotechnology in Animal Husbandry 26, 389-94.

Savić M., Jovanović S., Živković D., 2011, Production standards and the quality of milk and meat products from cattle and sheep raised in sustainable production systems. Biotechnology in Animal Husbandry 27 (3).

Data about the Hungarian indigenous breed, examination of Racka sheep meat

János Seregi[1], Ágnes Kovács[2], Károly Rozgits[3]

[1] University of Kaposvár, 7400 Kaposvár, Guba Sándor u. 40. Hungary,
[2] Szent István University, Faculty of Veterinary Science, Dep. of Food-Hygiene, 1078 Budapest, István u. 2. Hungary,
[3] District Office of Animal Health and Food Control Érd**,** 2030, Érd, Bethlen G. u. 37. Hungary

ABSTRACT

The authors analyse the role and the importance of Hungary's main, traditional /native, indigenous/ specie, the Racka (Ratzka) sheep, in the organic animal husbandry from the point of view of producing good-quality and healthy food. In the experiments the husbandry conditions and dietary systems were changed. The herd was divided into two groups. One of them was reared with "intensive" technology, the other with "extensive" /traditional rearing/ technology. The two methods have been compared. The following characteristics have been analysed: the slaughtering values, the CT test results performed on the slaughtered carcasses, analytical chemical and physical traits, quality and technological value of the meat. It has been confirmed that the Hungarian indigenous domestic animals reared in the "extensive", organic husbandry conditions compensate the lower output with their better quality. These products are healthier and more delicious. The ratio of *n6/n3* fatty acids and CLA content of the meat produced by organic methods are more favourable. For the human nutrition it is recommended to consume food containing less quantity of saturated fatty acids (SFA). But the consumption of meat rich in polyunsaturated fatty acids (PUFA), mainly the *n-3* (*omega-3*) fatty acids and **conjugated linoleic acid (CLA)** is highly favourable. The organic products are made without using nitrates and nitrites. The product colour, microbiological conditions and the tendency for rancidity did not diverge. With the aim to follow the origin of the products, a DNA analysis method has been used. Using the "Typi-Fix" method samples were taken from live animals, raw meat and the final product. The results confirmed that the species and subspecies can be determined from end products, as well. Thereby the origin of meat can be unambiguously determined which is important for the traceability and food safety of the meat products. The authors, through their experiments, feel to emphasize the importance of the Hungarian indigenous Racka sheep and the positive nutritional role of the meat originated from the extensive organic animal breeding.

Keywords: extensive, organic, intensive, rearing, Racka sheep, meat quality, meat functional properties

INTRODUCTION

The healthy food production requires that the animal feeding to be performed on the most appropriate manner, their living conditions should be developed accordingly, which is also a conscious effort in the organic animal husbandry. In this sense, the agricultural culture is closely related to the eating culture. The bases of good meat products are the ensuring of animal welfare, the indulgent slaughter and the good cuisine. The manufacturing of organic food products takes into consideration the traditions, the regional specialties, and their conscious use in the production. The Common Agricultural Policy of the European Union created a new situation in the Hungarian food sector, too. It emphasizes the need to strengthen the production and marketing of Hungarian traditional products in the EU countries. Furthermore, it takes into consideration the new consumer trends. For manufacturing Hungarian traditional food products indigenous animals can be used as raw materials. They are the Mangalitza pig, the Hungarian Grey cattle and the Racka sheep, which are on a large extent adapted to Hungary's climate and geographical conditions (*Kovács et al., 2003*). They also have special characteristics as well, excellent meat and fat quality and favourable fatty acid composition. It can be stated, that the market of organic meat products is slowly but continuously increasing. The consumers have a growing demand for safe products, manufactured under controlled conditions, free of harmful substances. There are a growing number of conscious consumers, who care their health, who demands that the food consumed have high nutritional value and good quality; also demand environmental-friendly production techniques and animal welfare. These processes have already begun in some EU countries much earlier, but now this can be seen in Hungary, too. However, in Hungary the production of organic meat products is less developed. This is due to the less animal density and due to the lower development of organic raw material production (*Seregi et al., 2014*). Hungary has a few producers, but their number is increasing, such as the product variety. There can be found on the market some Mangalitza and Hungarian Grey cattle products, and some poultry products, as well.

The organic animal breeding is important also from environmental protection point of view. Plays an important role in reducing the quantities of agricultural chemical substances, modifying and regulating the agronomical technologies (*Radics Seregi, 2005*), and emphasizing the animal welfare.

The aim of the study was to determine the functional and nutritional properties of the traditionally reared Racka meat.

MATERIALS AND METHODS

Two groups of indigenous Racka sheep have been reared by different technologies: in extensive organic system in the pasture and in the intensive system fed by forage and housed in corrals. Their experimental period was four month. The numbers of animals were forty: ten white and ten black male, and ten white and ten black female sheep. After the slaughter the samples for meat quality analyses were taken from the following parts: *M. semitendinosus* (ST), *M. biceps femoris* (BF) and have been performed according to Hungarian and ISO Standard methods. The CT (computed tomography) tests have been performed on the carcasses.

The pH measurements have been performed at 24 hours after the slaughter. The colour was measured on the fresh cutting surface with Minolta Chroma meter. The dripping loss was performed at 4 °C. The frying loss was measured after heat treatment at 72 °C core temperature. (*Weeler et al., 1998; Seenger et al., 2003*). The Warner-Bratzler shear force and the sensory evaluation were performed on the fried samples. The DNA (Typi-Fix) analyses have been performed on samples taken from live animal, (Figure 1), from raw meat and meat products. (*Brem et al., 2003*).

Figure 1: "Typi-Fix" sampling of the Racka sheep ear

RESULTS AND DISCUSSION

The effect of the different breeding methods was observed on the fattening and slaughtering parameters. During the 4 month of the experimental period, the daily weight increase of the animals was as follows: for the intensively housed animals 70.8 g, and for the extensively reared animals 48.2 g. The pH value, the colour of the raw meat sample and the dripping loss did not show significant differences between rearing technologies. For the frying loss and the Warner-Bratzler shear force slightly higher values have been found for the meat samples of extensively reared animals. The functional properties of the Racka sheep meat are shown in Figure 2 and Figure 3.

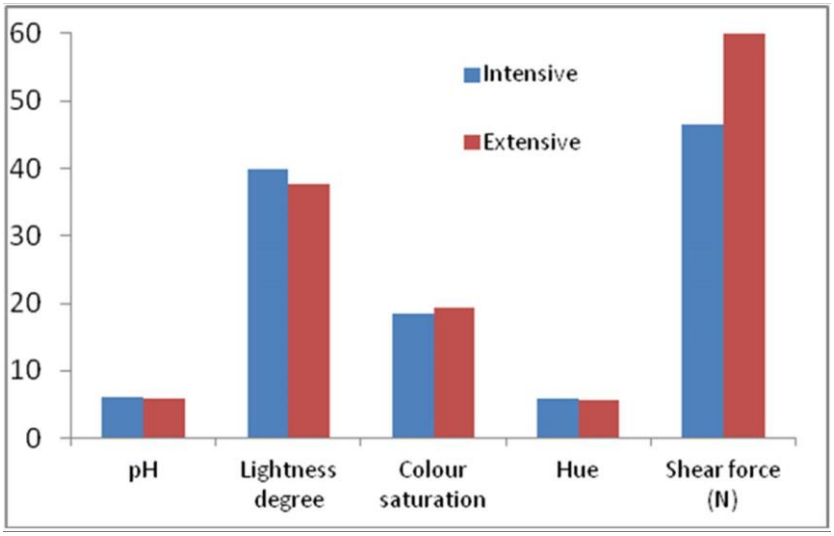

Figure 2: Characteristics of Racka sheep meat

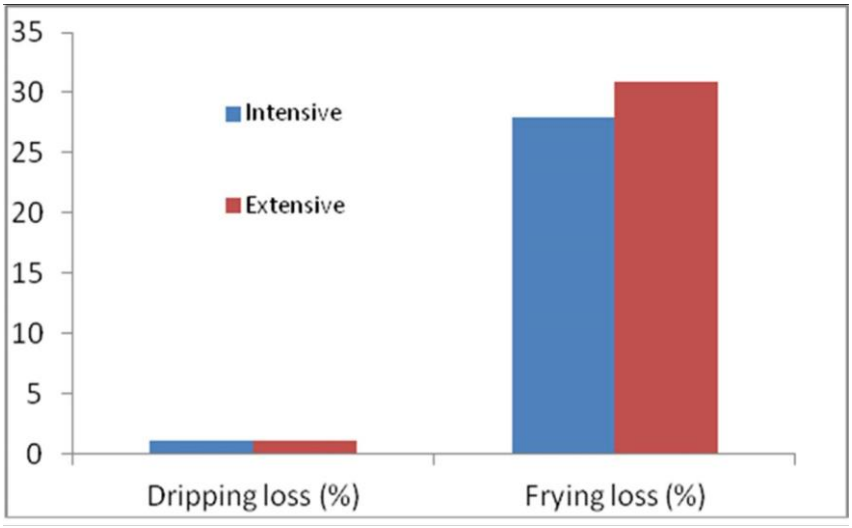

Figure 3: Dripping and frying loss of Racka sheep meat

The differences in frying loss and WB shear force might be caused by the differences in the connective tissues structure, by the higher mechanical strength. The texture of meat originated from extensively reared animals was more firm like the intensive ones. The results of chemical analyses did not show significant differences in moisture, connective tissue and protein content, but there was low fat content of the extensively produced meat (Figure 4).

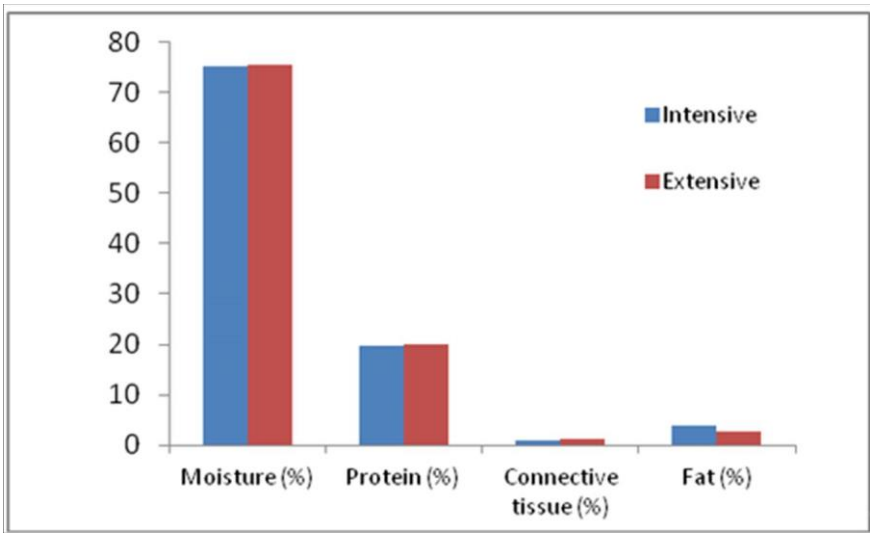

Figure 4: Chemical characteristics of Racka sheep meat

The results of CT (Computed Tomography) analyses have been showed that the extensive, organic breeding favours a better lean meat development and gives lower tallow content (Tables 1 and 2).

Table 1: CT results of Racka sheep for different breeding technologies

	Intensive	**Extensive**
Muscle tissues (%)	53,5	59,9
Fat tissues (%)	25,2	16,6
Other tissues (%)	21,3	23,5

Table 2: CT results of Racka sheep for different gender

	Ram	**Ewe**
Muscle tissues (%)	57,2	55,4
Fat tissues (%)	19,8	23,0
Other tissues (%)	23,0	21,6

The results of organoleptic evaluation have shown that the meat samples from extensive rearing have been slightly tougher, firmer and less juicy. The intensity of "sheep-aroma" and taste was higher for the intensively reared group. The DNA analyses have been performed from raw meat and product samples. The results have shown that the animal races and species can be identified from meat products, as well (*Brem et al., 2003*). This means that the origin of a product can be also determined.

CONCLUSION

The Racka sheep is on of Hungary's indigenous animals, traditionally reared under organic conditions. The meat and meat products originated from Racka sheep and other indigenous animals are valuable for their special quality and nutritional value. Furthermore, they can serve as palatable varieties in the globalised EU food market. The results of the experiments stated that the extensive organic animal breeding gives lower meat yield, but this fact is compensated with better product quality traits. The organic breeding favoured the fat composition, the n-3 fatty acid content of the meat and meat products, too. These products pay in an important role with their positive nutrition values. Moreover, they are more delicious and palatable. In Hungary several food products originated from traditional breeds and manufactured under traditional and local technologies are considered national values, are denominated "Hungaricums", and are listed in a national register (*hungarikum.hu*). Each country has the duty to protect its indigenous breeds and traditional food products, and to give all these values to the next generations as a respectable heritage.

REFERENCES

Brem G., Seregi J., Holló G., Repa I. 2003. A new (Typi-Fix System) method used for food quality assurance and for determination of residual materials in food. (Új módszer (Typi-Fix System) a minőségbiztosításra és a maradványanyagok kimutatására a húsban). In: Acta Caposvariensis. Hungarian.

Kovács F., Seregi J., Bodó I. 2003. Our indigenous animals and their products, the Hungaricums. (Őshonos állataink és termékeik a Hungarikumok). MTA, Budapest, 13-117.

Radics L., Seregi J. 2005. Manufacturing organic animal products. (Ökológiai szemléletű állatitermék-előállítás). Szaktudás Kiadóház, Budapest, 11-290.

Seenger J., Ábrahám Cs., Szűcs E., Ender K. 2003. Comparison of meat tenderness test methods. (Porhanyósság meghatározási módszerek összehasonlítása marhahúsnál). A HÚS 13, 141-144.

Seregi J., Pusztai P., Gál I. 2014. Data for the introduction of environment protective, organic animal breeding in Hungary and conditions for implementation. (Adatok a környezetkímélő öko-jellegű állattenyésztés hazai bevezetésének és működési rendszerének feltételeihez). MNVH, Budapest, 2014.

www.hungarikum.hu. Hungary's national register of Hungarikums. 2015.

The importance of goat milk and meat in the human nutrition

Ágnes Kovács[1], János Seregi[2]

[1] Szent István University, Faculty of Veterinary Science, 1078 Budapest, István u. 2. Hungary
[2] University of Kaposvár, 7400 Kaposvár, Guba Sándor u. 40. Hungary

ABSTRACT

The authors summarize the importance of goat meat and milk in the human nutrition, and try to raise the goat milk- and meat products to their well-deserved place, emphasizing their functional properties, their special taste, aroma and palatability. The consumption of goat milk and meat is much higher in several other EU and non-EU countries than in Hungary. The goat milk is free and safe regarding the TBC pathogens. In the past, when milk was not heat treated, it was currently used as being a safe food compared to cow milk. It has several health effective properties, such as increasing the general resistance ability. Today is confirmed, that it can be easy digested, it is rich in minerals and essential amino-acids, with very high nutritional value; and the dairy products having remarkable place in the modern healthy nutrition. Nowadays these products can be considered as functional foods, mainly if the animals are raised in organic conditions. The goat meat is also very valuable, having low fat content and being very palatable. It has a light-sweet taste, so with a proper special spicing the best food can be prepared. The food products originating from goat milk and meat, mainly the different cheese specialties can proudly enrich the menus of festivities and holiday dishes.

Keywords: health, organic food, human nutrition, organic breeding

INTRODUCTION

Goats are ancient inhabitants of the Carpathian basin, they have been carried on by our ancestors. The consumption of goat milk and meat was usual for the Hungarian conquerors, although they could use every raw material originating from goats (*mjksz.hu, 2014*).

Hungary does not attach so much importance to the goat milk and dairy products, as other countries with major goat husbandry, like France, Spain, Greece and The Netherlands. In the post-war period a few generations grew up as their basic food was the goat milk. Moreover in some regions the goat milk was used as a therapeutic food due to its general resistance enhancing effects. The goat milk is easy digestible, it is rich in vitamins, minerals and essential amino-acids, being a valuable source of nutrients. The goat milk is recommended for children, for elderly, also after illnesses in convalescence period, or for digestive disorders.

Nowadays goat cheeses from the family farms production are already available in the Hungarian market, beside more expensive imported goat cheeses. Many of these Hungarian cheeses are also of an excellent quality, having clear taste and proper texture, with adequate shelf life, and their "goat flavour" is not as intense as of the imported cheeses. The international recognition of Hungarian goat dairy products is also increasing *(Polgár and Toldi, 2011*).

Goats have very high milk producing capacity. Normally, during a lactating period, a goat can produce several times more milk than its own weight. This is a very important property from economic point of view, too. Regarding animal husbandry, goats have several biologically and economically positive characteristics, such as: rapid growth, high progeny, high adaptability and resistance against extreme climate and environmental conditions (*Ferenczy, 2011*).

MATERIALS AND METHODS

The goat milk

The healthy human nutrition and the protection of health requires adequate food consumption. The milk is one of our main foods. Milk and dairy products are very important not only in childhood, but for adults and elderlies, too. Milk is a resource of energy, with easy digestible proteins, vitamins, minerals, and also providing the important calcium necessary for bones (*Kukovics, 2001*). The positive nutritional effects of goat milk, meat and their processed products must be emphasized, also their significant role in the variety of human nutrition.
The milk of small ruminants shows a larger deviation in the composition – compared to cow milk - which is the consequence of their feeding. The variety of feed consumed by small ruminants will result in a variation of fat, protein, vitamin and mineral content in milk. The significance of vitamins (e.g. B_{12}), folic-acid and iron content of the goat milk must be strongly emphasized. The milk is one of foods containing the most bio-active materials. The whey proteins are richer in bio-active compounds than the casein. The lactose is very valuable due to its prebiotic (lactitol, lactulose) content that can enhance the growth of probiotics; and participates as an adjuvant in the calcium metabolism. The most important mineral in milk is calcium. Potassium content is three times higher than the sodium content. The selenium content has an antioxidant effect. The protecting effects of milk vitamins are also well-known (B_6-, B_{12},

folic acid). The milk has also a significant role in maintaining the acid-basis equilibrium of the human body. Goat milk is protected from the BSE prions, as well (*Kukovics, 2001*).

The goat meat

The goat meat is a very palatable food and has several positive physiological effects and nutritional values. It can be prepared in various ways, but the most usual is whole-fried or stuffed. The goat meat is slightly sweet, so the spicing must be done with more attention. A very pleasant taste and aroma can be obtained with frying together goat meat and cheese. The cheese melted on the meat surface generates a true gastronomic specialty. The best meat yield is given by eight to ten weeks old kids. The meat can be prepared in various ways, fried in slices or in whole, stuffed, schnitzel, stew or goulash. With curing or soaked in milk, or spiked with bacon, more palatable dishes can be prepared (*mjksz.hu, 2014*).

RESULTS AND DISCUSSION

Beside meat production, the milk production is the largest and most efficient sector of the goat husbandry. Regarding the data published by FAO, the goat milk considering the worldwide milk production in 2011 and was situated on the third place. The first place with the highest quantity was for cow milk. The second place had buffalo milk, which dominating mainly in Asian countries. The goat milk has an important role not only in Asian or African countries, but in Europe, too. Even if is present only with a fraction of the whole quantity. The most important goat milk producing countries in Europe are Greece, France and Spain (*Kukovics, 2013*).

The 2011 FAO statistical data shows that the world milk producing (Figure 1.) goat population is nearly as high as the half of the meat producing (Figure 2.) goat population.

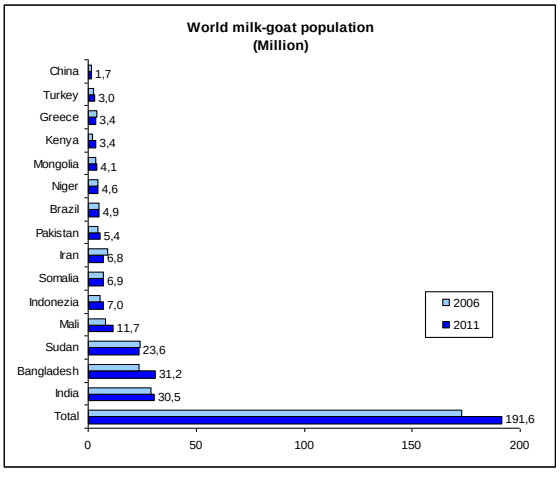

Figure. 1: World milk-goat production

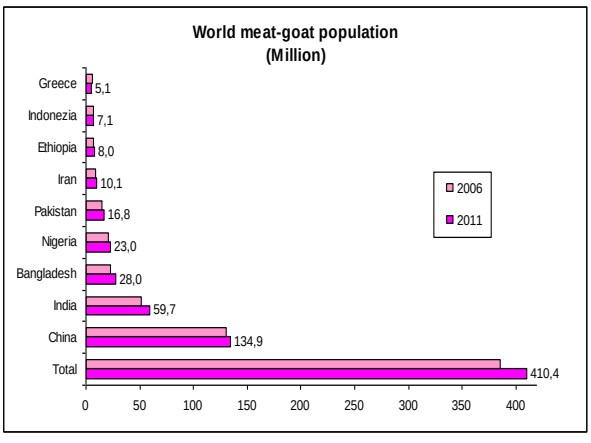

Figure. 2: World meat-goat production

The largest goat milk producing countries are: India, Bangladesh and Sudan. The most important meat producers are: China, India and Bangladesh. Regarding European countries, Greece is the most important for both (milk and meat) goat products (Figure 1 and 2.) (*fao.org, 2014*). China is the largest goat meat producer with more than 400 million goats; but regarding the livestock of milk goats, China has „only" 1,7 million animals (*fao.org, 2014*). According to the number of the slaughtered animals, Asia is on the first and Africa on the second place. The meat production of Europe and America is much lower (*Kukovics, 2013*).

Consumers can select from a wide variety of goat dairy products. There are two trends in the cheese production technology in the EU. In The Netherlands, Denmark and Germany the dairy industry produces huge quantities of goat cheeses processed by precisely engineered and controlled technologies. In United Kingdom, Switzerland and France the cheese specialities are manufactured in small farms under organic conditions, following traditional recipes. The highest quantity of goat cheese worldwide is prepared in France. Soft cheeses are manufactured in United Kingdom flavoured with nuts, green spices, herbs and garlic. Greeks and Bulgarians prefer mainly hard cheeses. Spreadable and Roquefort-type cheeses are very popular in France. Fermented products are mostly manufactured in the Middle-East, Greece and Turkey. There is no industrial production of goat yoghurt in the EU, because the special, intense aroma is not really appreciated by the EU consumers (*Szigeti, 2005*). The processing of goat milk is performed only in a few small or middle dairy plants in Hungary. The plants have to overcome several difficulties, such as the dispersion of the breeding farms, or the products imported from other EU and neighbouring countries. Despite all these facts there are also positive experiences like the newly developed probiotic products and their novel processing technologies (*Szakály and Unger, 1998*). The goat probiotic products are novelties, enhancing the positive characteristics of the goat milk. The probiotic products have several effective nutritional and health values. The fermented goat dairy products manufactured with inulin have no special goat flavour, which is a great advantage for the consumers who reject goat products due to their specific intense goat aroma. The higher price in several cases is a barrier for the consumers, but in case of goat dairy products their price is proportional with their value. The nutrition factors of goat milk are also very favourable compared to cow milk (*Szigeti, 2005*).

The goat milk contains slightly less lactose than the cow milk. The goat milk is rich in fat and has slightly more essential fatty acids than the cow milk (Table 1). These fatty acids are playing an important role in the function of immune-, nervous- and cardio-vascular systems, furthermore in the prevention of several diseases. The goat milk contains more fatty acids of medium chain length (C4-C10). These are easily and rapidly utilizable energy resources, even having reduced absorbing surface (*webbeteg.hu, 2013*).

Table 1: Comparison of goat and cow milk

Milk (100g)	**Energy (kcal)**	**Protein (g)**	**Fat (g)**	**Essential fatty acids (g)**	**Cholesterol (mg)**	**Carbo-hydrates (g)**
Goat	70	3.6	3.9	0.12	11	4.7
Cow (2.8%)	60	3.4	2.8	0.13	10	5.3

(*webbeteg.hu, 2013*)

Compared to the cow milk, the fat content of goat milk is dispersed into much smaller fat globules; so is easier digestible, because is more accessible by the digestive enzymes. The butter manufactured from goat milk maintains its white colour even if the goat was fed with green forage, because the beta-carotene is transformed into vitamin-A. This process is not present in the cow milk. The lack of vitamin-A in some cases may be complemented by drinking goat milk (Table 2). Regarding chemical composition, goat milk also contains higher quantities of water- (B_1, B_2, B_6, D, C) and fat-soluble (E, K) vitamins. The goat milk has the effect to convert carcinogen substances into less harmless ones, so might be used as a preventive food. Goat milk might be also consumed by several persons having casein intolerance. The goat milk casein precipitates in smaller flakes than cow milk casein, so is better digestible. It has also higher amino-acid content. An amount of 0.2 litre of milk can provide the daily amino-acid need for an adult consumer. The goats need a diversity of feed, so they consume a wide variety of plants. This feature can be used to feed them with medical herbs, so that therapeutic-milk can be obtained. The whey of goat milk is widely used by the cosmetic industry (*mjksz.hu, 2014*).

Table 2: Vitamin content of goat and cow milk

Milk (100g)	**A (µg)**	**C (mg)**	**D (µg)**	**B1 (µg)**
Goat	60	5	0.25	50
Cow (2.8%)	15	1	0.02	35

(*webbeteg.hu, 2013*)

In comparison with cow milk, goat milk contains higher quantities of potassium, sodium and phosphor, but less magnesium. Actually each "part" of goat is useful. The fat tissues of goat – unlike sheep fatty tissues – are not incorporated into the muscle tissues, so the goat meat does not contain tallow. The lean meat, without fat, is easy digestible, so it can be used for dietary dishes, too. Despite of all these positive effects, many people does not prefer to consume goat meat. The goat meat is healthy and palatable; its taste can be compared with sheep meat, but according to experts, it is tastier. It is very delicious when prepared as stew or fried (*Kocziha, 2014*). The slaughter weight for kids is about 30 kg, which is reached for an age of 18-24 weeks, depending on feeding conditions. The meat of older animals is going to be darker and tougher, and the fatty tissues yellow. The yield of lean meat is high enough for goats, due to the lack of subcutaneous fat. It must be also mentioned the goat breeds, bred for their very valuable fleece used by the textile industry. They are so called fibre goats (e.g. cashmere goats are fibre and meat goats) (*Swatland, 2000*). Goat meat, as red meats usually have in their composition higher biologically active haemoglobin content. The haem-iron is better accessible and also helps the metabolism of non-haem iron. In table 3 some typical goat meat compositional data are presented (*Casey, 1992*).

Table 3: Mean composition of goat meat (concentration of minerals: mg/100 g)

Composition	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Ca	P	Mg	K	Na	Cu	Zn	Fe	Mn
Goat meat	64.2	29.2	4.7	0.87	11	155.5	19.7	350	64.5	0.3	3.5	4.4	0.09

CONCLUSION

Goat food products represent an important nutrient source especially for consumers of developing countries, which regions account more than 90% of the estimated world goat population. For western consumers the goat products - mainly the dairy products - are considered luxury goods. Nowadays the consumers' trends are undergoing important changes; the foods with special quality traits are very popular. The goat meat and dairy products have high nutritional values and fulfil the expectations of consumer groups preferring special quality and organic food products. Last but not least goat products contribute to the enjoyable healthy human diet, enriching it with their variety.

REFERENCES

Casey N. H. 1992. Goat meat in human nutrition. V. International Conference on Goats, New Delhi, 1992.

Ferenczy F. 2011. 1st Milk Hygiene Quality and Analysis World Congress, Transylvania, Romania, 2011.

http://www.fao.org/statistics/databases/en 2014. Food and Agriculture Organization of the United Nations, Statistics, Databases, Global Livestock Production and Health Atlas (GLiPHA), 2014.

http://mjksz.hu. 2014. Hungarian Sheep- and Goat Breeders Association / Magyar Juh- és Kecsketenyésztő Szövetség oldala: 2014. Hungarian.

Kocziha J. 2014. The goat meat. / A kecskehús. http://mindenamikecske.hu, 2014. Hungarian.

Kukovics S. 2001. The role of the milk in the human nutrition. / A tej szerepe az emberi táplálkozásban, Új Diéta. A magyar dietetikusok lapja, 2001/3-4, p18. Hungarian.

Kukovics S. 2013. Goat races and race group types. / Kecskefajták és fajtacsoportok. Magyar Juhászat és Kecsketenyésztés. 22. 2013/4, p3. Hungarian.

Polgár P., Toldi Gy. 2011. Sheep- and Goat Husbandry. / Juh- és kecsketenyésztés, Kaposvári Egyetem, Digitális Tankönyvtár, 2011, 13. fejezet. Hungarian.

Szakály S., Unger A. 1998. Quality development in the Hungarian milk production. / Minőségfejlesztés a hazai tejgazdaságban, AGRO-21 Füzetek, 1998, (21), p52-68. Hungarian.

Szigeti O. 2005. Marketing strategy and consumer behaviour regarding goat dairy products. / Marketingstratégia és fogyasztói magatartás a kecsketej alapú termékeknél, Kaposvári Egyetem, 2005. Hungarian.

Swatland H. J. 2000. Meat cuts and muscle meat. Nottingham University Press. 2000.

www.webbeteg.hu, 2013. The goat milk. / A kecsketej 2013. Hungarian.

Production traits of hens, physical characteristics of eggs and cholesterol content in eggs from the Slovenian traditional egg laying chicken breeds

Dušan Terčič, Mojca Pestotnik

University of Ljubljana, Biotechnical Faculty, Department of Animal Science, Groblje 3, SI-1230 Domžale, Slovenia

ABSTRACT

Three Slovenian traditional egg laying chicken breeds (Slovenian Brown Hen, Slovenian Silver Hen and Slovenian Barred Hen) were monitored for total egg production, some physical characteristics of eggs and cholesterol content in the yolk. In the period between 20 and 72 weeks of age, the Slovenian Brown hens were the lightest, produced the highest amount of eggs, and were the most vital. Throughout the experiment, the highest body weight was noticed in the Slovenian Barred hens. The eggs were significantly ($P \leq 0.05$) lighter with significantly thinner and brighter eggshells in comparison with the other two breeds. The Slovenian Silver hens were the first among the studied breeds to reach the peak production and produced eggs with significantly ($P \leq 0.05$) brighter yolks in comparison with other studied breeds. The cholesterol content did not significantly differ among yolks of the three traditional Slovenian chicken breeds.

Keywords: egg layers, production traits, physical characteristics of eggs, cholesterol

INTRODUCTION

Slovenian traditional egg laying chicken breeds are the Slovenian Barred Hen, the Slovenian Silver Hen and the Slovenian Brown Hen. The label traditional means that these breeds do not originate in the Republic of Slovenia but have been bred in Slovenia continuously for over 30 years and always subjected to breeding and selection activities. The crossbreeding of the mentioned breeds has given three diverse coloured final crossbreeds for production of table eggs with the commercial name Prelux. We have to test pure breeds occasionally because of monitoring the production, feed consumption, mortality and eggs quality. Thus, we breed them from the beginning of the laying period under the uniform rearing conditions in the floor system, and later move them into cages where the above traits are monitored up to 72 weeks of age when the first laying period ends. The aim of this study was to show the quality of eggs, production traits and the cholesterol content in yolks produced by three traditional breeds in two studies.

MATERIAL AND METHODS

The experiment was carried out at a poultry research station and egg quality analyses were performed in the chemistry lab (Biotechnical Faculty, University of Ljubljana, Slovenia) with the approval of the Commission for Animal Experiments of the Institution. The experiment comprised 34 hens of each of three breeds: the Slovenian Brown Hen, the Slovenian Silver Hen and the Slovenian Barred Hen, which were reared in the same poultry house in the floor system until 20 weeks of age. Then hens were moved into individual battery cages where we monitored production traits (egg production, body weight), physical characteristics of eggs and mortality rate between ages 20 and 72 weeks. The hens had drinking water and complete feeding mixture for egg layers *ad libitum*. Sample weighing was carried out at ages 18, 52 and 72 weeks. We monitored egg production of each hen daily and noted mortality. Every four weeks we took a random sample of 15 eggs from all three breeds and measured the following physical characteristics: egg weight, colour and thickness of the shell, the height of albumen and yolk colour. The thickness of shell was measured with mechanical micrometer. All other characteristics were measured with a set of electronic apparatus developed at the University of York, Great Britain (Technical Services and Supplies of York) (Ristić, 2010). Based on egg weight and albumen height, we calculated Haugh units. In one of the previous studies (Tavčar, 2009), a sample of 12 heaviest eggs was taken from three breeds that were fed with complete feeding mixture for egg layers at 50 weeks of age. Cholesterol from the egg comes exclusively from the egg yolk. The content of cholesterol in yolks was measured after the lyophilisation with enzyme method (KIT) and with spectrophotometric method with iron (III) chloride (Tavčar, 2009). The obtained data were processed with the software package SAS/STAT (SAS Inc, 2001).

RESULTS

Production results

Table 1. Average production results of the Slovenian traditional egg layers (adapted from Ristić, 2010)

Breed	Age at 50 % production (weeks)	Peak egg production (%)	Eggs per hen-day in the period from 20 to 72 weeks	Liveability (%)
Slovenian Brown Hen	21	95.38	304	100.00
Slovenian Barred Hen	24	81.09	241	97.06
Slovenian Silver Hen	21	97.06	293	94.12

Table 2. Estimated mean values for body weight of Slovenian traditional egg layers at age 18, 52 and 72 weeks (adapted from Ristić, 2010)

Breed	Age (weeks)		
	18. LSM ± SE	52. LSM ± SE	72. LSM ± SE
Slovenian Brown Hen	1541 g ± 40	1844 g ± 40	1982 g ± 41[a]
Slovenian Barred Hen	1924 g ± 40	2729 g ± 40	2841g ± 41[b]
Slovenian Silver Hen	1753 g ± 40	2087 g ± 40	2273 g ± 42[c]

LSM – estimated mean value of trait, SE – standard error of estimation

[a,b,c] Means followed by the same letters in the same column are not significantly different (P>0.05)

Physical characteristics of eggs

Table 3. Estimated mean values with standard errors for physical characteristics of eggs from the Slovenian traditional egg laying chicken breeds (adapted from Ristić, 2010)

Breed	Egg weight (g)	Shell colour (%)	Haugh units	Yolk colour (Roche)	Shell thickness (mm)
	LSM ± SE	LSM ± SE	LSM ± SE	LSM ± SE	LSM ± SE
Slovenian Brown Hen	62.53 ± 0.35[a]	40.43 ± 0.50[a]	81.81 ± 0.63[a]	12.94 ± 0.045	0.37 ± 0.0022[a]
Slovenian Barred Hen	60.18 ± 0.35	49.30 ± 0.50[b]	80.68 ± 0.62[a]	13.22 ± 0.045[a]	0.34 ± 0.0022
Slovenian Silver Hen	62.77 ± 0.35[a]	37.25 ± 0.50[c]	83.16 ± 0.62[a]	13.14 ± 0.045[a]	0.38 ± 0.0022[a]

LSM – estimated mean value of trait, SE – standard error of estimation

[a,b,c] Means followed by the same letters in the same column are not significantly different (P>0.05)

The cholesterol content in yolk

There were no statistically significant differences between the methods that were used for determination of cholesterol in yolk; hence, only data obtained by enzyme method (KIT) are presented.

Table 4. The estimated values with standard error of estimation for the cholesterol content in the eggs from Slovenian traditional breeds of hens (adapted from Tavčar, 2009)

Breed	Cholesterol content (mg/g) fresh yolk
	LSM ± SE
Slovenian Brown Hen	14.19 ± 0.38[a]
Slovenian Barred Hen	14.93 ± 0.38[a]
Slovenian Silver Hen	14.03 ± 0.38[a]

LSM – estimated mean value of trait, SE – standard error of estimation

[a,b,c] Means followed by the same letters in the same column are not significantly different (P>0.05)

DISCUSSION

The Slovenian Barred hens reached 50% egg production later (24 weeks) than the Slovenian Brown hens and the Slovenian Silver hens (21 weeks). The Slovenian Barred hens had lower peak production (81.09%) in comparison with other two traditional breeds with the peak production at 95.38% (Brown) and 97.06% (Silver), respectively. The egg yield/hen reached the highest level of 304 eggs in the Slovenian Brown hens and the lowest level of 241 eggs in the Slovenian Barred hens. The highest mortality rate and the lowest liveability, respectively were recorded for the Slovenian Silver hens (94.12%) while no mortality was noticed in the Slovenian Brown hens, i.e. the liveability was 100%. The Slovenian Barred hens laid statistically significantly (P≤0.05) lighter eggs than the other two breeds. The shell colour significantly (P≤0.05) differed among the three breeds. The Slovenian Silver hens laid eggs with the darkest shells whereas the Slovenian Barred hens had the brightest eggs. Haugh units were correlated with the height of the albumen; consequently, the quality of albumen was shown. The breeds did not (P≥0.05) statistically significantly differ in this trait. The Slovenian Brown hens laid eggs with significantly (P≤0.05) brighter yolks whereas the colours of yolks from the Slovenian Barred hens and the Slovenian Silver hens did not differ (P≥0.05). The thickness of shell did not significantly differ (P≥0.05) between the Slovenian Brown hens and the Slovenian Silver hens while the Slovenian Barred hens laid eggs with significantly (P≤0.05) thinner eggshell. The lowest cholesterol content (mg/g fresh yolk) was noticed in the eggs from the Slovenian Silver hens, 14.03 ± 0.38 g, whereas the highest content had eggs from the Slovenian Barred hens (14.93 ± 0.38 g). The comparison among breeds showed that this trait did not demonstrate statistically significant differences.

CONCLUSIONS

- The estimated mean values for body weight showed that the Slovenian Brown hens were the lightest at the beginning (1541 g) and at the end of the laying period (1982 g). The Slovenian Barred hens had the highest body weight at the age of 18 weeks (1924 g), and at 72 weeks when the laying period was finished (2841 g).
- The Slovenian Barred hens reached the peak production later (age 24 weeks) and it was lower (81.09%) than in the Slovenian Brown hens and in the Slovenian Silver hens that reached peak production (95.38% and 97.06%) at age 21 weeks.
- Until the age of 72 weeks, the Slovenian Brown hens were able to lay 304 eggs/hen, and reached 100% of liveability.
- The Slovenian Barred hens laid the lightest eggs (60.18 ± 0.35 g) with the brightest (49.30 ± 0.50%) and the thinnest (0.34 ± 0.0022 mm) eggshells. The highest Haugh units were calculated for the eggs from the Slovenian Silver hens, whereas the lightest yolks were found in the eggs from the Slovenian Brown hens.
- The egg yolk cholesterol level was not affected by the chicken breed.

REFERENCES

Ristić M. 2010. Comparison of production results of Slovenian traditional breeds of light type laying hens and their hybrids. Graduation thesis. Ljubljana, Biotechnical Faculty, Department of Animal Science: 48 p.

SAS Inst. Inc. 2001. The SAS System for Windows, Release 8.02. Cary, NC, SAS Institute.

Tavčar T. 2009. Cholesterol content in the eggs of Slovenian local breeds of hens. Graduation thesis. Ljubljana, Biotechnical Faculty, Department of Animal Science: 45 p.

Free communication program

Breeding of Slavonian Syrmian Podolian on Gajna grassland and its role in preservation of tradition and biodiversity

Pero Mijić[1]; Mario Pavičić[2]; Iris Beneš[3]; Zdenko Ivkić[4]; Željko Burazović[5]; Goran Vučković[1]; Marija Špehar[4]

[1]Faculty of Agriculture in Osijek, K. P. Svačića 1 d, 31000 Osijek, Croatia
[2]Public Institution for management of protected natural areas Brodsko-posavska county – Natura Slavonica, P. Krešimira IV, 35000 Slavonski Brod, Croatia
[3]Brod Ecologycal Society, Trg hrvatskog proljeća 1, 35000 Slavonski Brod, Croatia
[4]Croatian Agricultural Agency, Poljana Križevačka 185, Križevci, Croatia
[5]Brodsko-posavska county, P. Krešimira IV, 35000 Slavonski Brod, Croatia

ABSTRACTS

Extensively utilized grasslands are among the most endangered habitats in Croatia and Europe. In some areas undermined by the intensification of production (fertilization and intensification of mowing, and draining and conversion to arable land), and elsewhere is a major risk their neglect and overgrowth in the bush. Without grazing, mowing and similar activities, pastures and meadows gradually heal to shrubs and finally forests. Breeding of Slavonian Syrmian Podolian cattle on pasture Gajna is a good example of ecological livestock based only on grazing. So it can produce healthy food, but also preserve the tradition of breeding and biodiversity of the environment with the highest environmental standards. The aim is to achieve a recognizable brand of ecological products while preserving the natural resources of the Republic of Croatia.

Keywords: Slavonian Syrmian Podolian, Gajna pasture, tradition, biodiversity

INTRODUCTION

In Croatia, in accordance to the Livestock Act (OG 70/97), original breeds are defined as breeds of domestic animals created on the Croatian territory. List of original and protected species and breeds of domestic animals bred on Croatian territory was published in the Official Gazette (OG 127/98, OG 73/03, OG 39/06, OG 126/07, OG 70/09). Three cattle breeds are threatened of extinction. From the economic point of view part of this population of domestic animals are not competitive with conventional breeds. However, they are surely having an important role in the conservation of biological diversity of animals, but also in the preservation of the traditions of a particular region in which they are incurred (Barać et al., 2011). One of those indigenous breeds of cattle is Slavonian Syrmian Podolian cattle. This podolian cattle belongs to the group of long-horn cattle *Bos taurus*, and it represent a domesticated form of the original *Bos primigenius*. At the beginning of the XX. Century Slavonian Syrmian Podolian was the most important and the most common breed of cattle in Baranja, Syrm and Slavonia as well from Podravina to Virovitica where it represents around 90% of the total number of cattle (HPA, 2015). Because of the importance of preserving this exceptionally important genetic resource, Croatia has certain financial aid contributed to the protection and preservation of this cattle breed (Barać et al., 2011). Significant revitalization of the Slavonian Syrmian Podolian in the area of the Brod-Posavina County began in 2007 where it is bred at protected pasture area near the river Sava called Gajna (BED, 2015). Sometimes this breed of cattle is bred mainly for useful work production, and prized beef. Milk production is about 800 to 1,000 litres per lactation. Slavonian Syrmian Podolian has very modest nutritional requirements, and most of the year it is kept on pasture. In the winter period cattle are hold in the area that protects it from the rain. Cattle are feed with the hay and the addition of grain.

The Sava River is one of the few examples with intact floodplains and rich biological diversity. This river flows through Croatia in total length of 562 km, of which in the Brod-Posavina County is 170 km (almost 1/3). The most important landscape characteristics are visible in the central part of the Sava basin with a mosaic of natural floodplains and cultural landscapes formed by traditional land use, typical of river valleys. In Brod-Posavina County such areas as special forest reserve Prašnik, flood Iva pasture near the village of Gorica, Jelas ponds, Dvorina pond, Gajna (Pavičić, 2011).

The aim of this study was to show the importance of Slavonian Syrmian Podolian cattle breeding, and its role in preserving biodiversity and balance of protected areas Gajna pasture near the Sava River in the area of the Brod-Posavina County.

Public and civil institutions in the landscape preserving

Gajna is one of seven protected areas in Brod-Posavina County. It is protected by a significant landscape, a typical Slavonian Prisavlje flooded pasture, important hatchery fish Sava and feeding waterfowl. It is located between the villages Oprisavci and Poljanci. The southern border of Gajna represents the Sava River and the border continues Sava River embankment, which is in the area away from the Sava. It forms a pocket in which is situated Gajna. Area landscape is 331.7 hectares (BED, 2015).

Public Institution for management of protected parts of the nature of the County - Natura Slavonica and Brod Ecological Society through the CARDS 2004 project, in cooperation with the Croatian waters from Slavonski Brod and the Municipality of Oprisavci is the example of how all of the above can be implemented in a concrete project in a protected floodplain area. Within the project "protection, conservation and improvement of biodiversity and developing ecological awareness through the breeding of native Croatian species and stimulating organic farming" with the aim of preserving the biodiversity of pastures, indigenous breeds; Black Slavonian pigs, Croatian Posavina horse, with a special emphasis on Slavonian Syrmian Podolian were purchased (Pavičić, 2011).

A special contribution to the preservation of biodiversity and landscape of the County has made by the Brod Ecological Society (BED). This society was founded in the year 1989 and it is one of the largest with visible successes which is reflected when 1990 Gajna get the status of a protected landscape. BED, as an association, supervises the implementation of the measures and conditions for nature protection in cooperation with the inspection services. It is a rare example where the association, in cooperation with the local community manage the protected area. The cooperation in this field has continued with the Public Institution for management of protected parts of the nature of the County – Natura Slavonica that since 2007 formally managed Gajna. BED today has 160 registered members and about 40 activists. So far participated in some 30 major projects related to the Sava River and its coastal trying to preserve the landscape, biodiversity, the environment, as well as traditional and cultural heritage of the Brod-Posavina County.

The role of Slavonian Syrmian Podolian in the conservation of biodiversity on protected pasture Gajna

At the protected area pastures Gajna, for many years there was a reduction in the number of livestock on the pasture. Because of this decrease, was growing of pastures in bushes and undergrowth, especially in invasive alien species - false indigo, also known as amorpha. Cvitnjača (*Amorpha fruticosa*) is spreading in the low-lying area, along the banks of rivers and lakes, canals, eves, forest edges and makes higher proportion of ruderal vegetation significantly suppressing the indigenous flora. Makes a great number of fruit, which drives away the flood water is weedy areas are increasing. The thick set of woody plants greatly overshadows the ground layer of the earth and destroys the characteristic grassland circuit wetland ("below Indigobusch nothing grows"). Destroying floral composition meadows significantly disappearing habitat of many rich protected and endangered fauna of meadows and pastures, leading to a reduction in the overall biodiversity of the protected area. Abandoned farmland rapidly heal the false indigo, and the process is rapidly spreading to new areas. The Slavonian Syrmian Podolian is proven as excellent in suppressing and non-native and aggressive plant species (Pavičić, 2011). Brod Ecological Society wishes to contribute to its activities to certain economic activities (eco-agriculture, tourism), thus ensuring the sustainable development of the surrounding rural settlements. Activists of BED consider the grazing key ecological process in this valuable habitat. Also, by free grazing to protect the local flora and stimulate the production of healthy food and Dredging ponds and the creation of plateaus would create conditions for controlled eco-tourism. The aim is to create adequate conditions so that local people remain in traditional ways of grazing, despite the lack of competitiveness of such breeding (BED, 2015).

Breeding cattle on pasture in Gajna gives completely green products, which are based solely on grazing and crop fodder produced without synthetic fertilizers, chemical protective agents and various additives, and therefore has significant medical value. The cattle that are all four seasons in this pasture in the open on a heat, cold, wind or rain, has resilience and vigor that presents a valuable genetic resource adapted these conditions (BED, 2015).
For this reason, preservation of distinctive landscape and biodiversity along the Sava River, presuming a further preservation of extensive livestock production, enabling local communities to maintain traditional agriculture, particularly the grazing of domestic animals. To maintain extensive livestock farming whilst ensuring a sufficient income for farmers is one of the leading challenges for the local community, but also the ministries in the field of agriculture, culture, tourism and forestry and water management to the protection of natural, cultural and traditional heritage to protect the interests of the Croatian. This would enable the survival of the population in the countryside and sustainable development through ensuring the preservation of natural and landscape values of these areas. Ministry of Agriculture of the Republic of Croatia is closely following the activities relating to the protection of native breeds of farm animals. In its report (MPRRR, 2010) it is stated that the original and protected breeds of domestic animals incentive reviving parts of rural areas, and that can contribute to the local population, the extra income. They are suitable for use and maintenance of pastures, preventing the devastation and succession habitat, in the programs of organic farming and the development of distinctive traditional brands. An integral part of the ecosystem upon which many other plant and animal species. In addition, the rural development measures the Croatian (MP, 2015), the original protected breeds of domestic animals are covered by specific financial aid.

Numerical indicators of Slavonian Syrmian Podolian

Ivankovic et al. (2006) state that the level of inbreeding (calculated based on genealogy) in Slavonian Syrmian Podolian was 0.0186. This data points to the systematic selection work with this breed, but also the seriousness of the situation regarding the strength of the population and distribution of the throat. In order to overcome the problem of population size, in year 2008 Breeders Association of Slavonian Syrmian Podolian in Slavonski Brod was established. This association gathered seven private breeders, seven corporations and several potential breeders. The experience, according to the Beneš et al. (2010), indicate a long way from the initial steps of this association to the quality of the contribution of these organizations and the impact on the legislative, strategic and other decisions. Most importantly, after the establishment of the mentioned Association the positive changes in terms of preserving Slavonian Syrmian Podolian, its expansion to the protected pasture areas, and ultimately preserve the landscape and biodiversity, was realised.

Table 1. The number of farmers, cows and bulls of Slavonian Syrmian Podolian in Brod-Posavina County (BPC) and in the Republic of Croatia (CRO) from 2005 to 2014

Year	Breeders		Cows		Bulls	
	BPC	CRO	BPC	CRO	BPC	CRO
2005	1	4	2	89	2	4
2006	1	4	2	74	1	3
2007	1	4	2	98	1	4
2008	3	10	29	107	3	9
2009	2	11	31	125	1	9
2010	8	17	47	143	5	14
2011	10	20	37	145	2	9
2012	5	14	33	167	1	9
2013	5	15	37	171	3	13
2014	5	15	53	179	3	14

The data presented in Table 1 show that the number of breeders of Slavonian Syrmian Podolian from 2012 to 2014 is equal. From 15 farmers (as there were in Croatia in 2014), five (or one third) is in the area of the County. It is encouraging that the total number of cows in the area of the County (53 cows), as well as of the Croatian territory (179 cows), and the number of bulls (3 and 14) is gradually increasing. According to official figures (HPA, 2014) published in the annual report for 2013 there were 13 bulls, 171 cows and 126 throat of the female offspring, all in property of 15 breeders. The effective population size is 48.33 and due to the effective population size, this breed is classified in the category IA – critically endangered. Research conducted by Čačić et al. (2013) regarding the analysis of pedigree data of Slavonian Syrmian Podolian identified certain shortcomings in the planning and in balanced mating of all bulls lines and cows genera, also certain shortcomings was determined in exclusion from breeding (slaughter house). The authors believe that due the establishment of the registry of the breed to date, part of genetic variability was lost.

Table 2. The number of Slavonian Syrmian Podolian breed in accordance to age in Brod-Posavina County (BPC) and the total in the Republic of Croatia (CRO) from 2005 to 2014

Year	< 1 year		> 1 year		Total	
	BPC	CRO	BPC	CRO	BPC	CRO
2005	1	33	-	26	1	59
2006	1	19	-	39	1	58
2007	2	37	6	23	8	60
2008	7	19	4	36	11	55
2009	8	36	15	43	23	79
2010	18	54	12	32	30	86
2011	24	58	6	45	30	103
2012	14	54	14	94	28	148
2013	9	34	21	92	30	126
2014	3	40	13	80	16	120

Table 2 presents the data on the number of Slavonian Syrmian Podolian cattle. Number of bred animals up to one year in 2014 in the area of the County was small (3), whereas this number was slightly higher for youths older than one year (13). Overall, breeding progeny Slavonian Syrmian Podolian in Croatia recorded an increase by 2013 (126 heads), and in 2014, stagnation (120 heads).

CONCLUSION

The preservation of indigenous and protected breeds of domestic animals in Croatia is important from economic, cultural and scientific reasons. Slavonian Syrmian Podolian should be preserved not only as a gene bank and the tradition of Slavonia, but should be selected for cultivation in protected areas (like pastures Gajna) for the conservation of endangered habitats and species of floodplain, which further contributes to the overall biological diversity of a certain area.

Cattle farming in areas that are protected under the Protection of Nature in which they are not used protective chemicals for the production in accordance with the highest environmental standards and the creation of a brand of ecological products while preserving the natural resources of the Republic of Croatia.

REFERENCE

Barać Z., Bedrica Lj., Čačić M., Dražić M., Dadić M., Ernoić M., Fury M., Horvath Š., Ivanković A., Janječić Z., Jeremić J., Kezić N., Marković D., Mioč B., Ozimec R., Petanjek D., Poljak F., Prpić Z., Sindičić M. 2011. Zelena knjiga izvornih pasmina Hrvatske. Ministarstvo zaštite okoliša i prirode - Državni zavod za zaštitu prirode, Hrvatska poljoprivredna agencija, Nacionalni park Krka, COAST/UNDP/GEF. Zagreb, 158-173.

Beneš Š., Beneš I., Ivanković A., 2010. Uvođenje novih linija u funkciji trajne zaštite Slavonsko-srijemskog podolskog goveda. 2. Konferencija o izvornim pasminama i sortama kao dijelu prirodne i kulturne baštine. Poreč, 22.-24. rujna 2010., Marković, D., Jeremić, J. (ur.). Zbornik sažetaka, s. 27.

Bobić T., Mijić P., Baban M., Sakač M., Bogdanović V., Klarić I. 2010. Važnost autohtonih pasmina goveda u očuvanju prirodne i kulturne baštine. 2. Konferencija o izvornim pasminama i sortama kao dijelu prirodne i kulturne baštine s međunarodnim sudjelovanjem Poreč, 22. - 25. 09. 2010. Marković D., Jeremić J. (ur.). Zbornik sažetaka. s. 21-22.

http://www.bed.hr/Gajna.html (15. travanj 2015)

Čačić M., Kljujev A., Bulić V., Brekalo B.,2013. Sistematizacija uzgoja izvorne pasmine goveda slavonsko-srijemski podolac. Stočarstvo, 67 (3), 99-111.

Hrvatska poljoprivredna agencija, 2014: Godišnje izvješće za 2013. godinu. Zagreb.

http://www.hpa.hr/odjel-govedarstva/slavonsko-srijemski-podolac/ (15. 04. 2015.)

Ivanković A., Orbanić S., Caput P., Mijić P., Konjačić M., Bulić V. 2006. Genetska struktura i održivost populacija autohtonih pasmina goveda u Hrvatskoj. Stočarstvo, 60 (1), 47-51.

http://www.azrri.hr/fileadmin/dokumenti-download/Nacionalni_program_o%C4%8Duvanja_izvornih_i_za%C5%A1ti%C4%87enih_pasmina_doma%C4%87ih_%C5%BEivotinja_u_RH.pdf (15. 04. 2015.)

http://www.mps.hr/ipard/UserDocsImages/Postpristupno%20razdoblje%20%20EAFRD/objava%20mjere%20RR%20za%202014/MJERE%20RURALNOG%20RAZVOJA%202014.pdf (On-line: 15. 04. 2015.)

Narodne novine 1997. Zakon o stočarstvu. N.N. 70/97.

Narodne novine 1998. Popis izvornih i zaštićenih pasmina i sojeva domaćih životinja te njihov potrebiti broj. N.N. 127/98.

Narodne novine 2003. Dopuna popisa izvornih i zaštićenih pasmina i sojeva domaćih životinja te njihov potrebiti broj. N.N. 73/03.

Narodne novine 2006. Izmjena i dopuna popisa izvornih i zaštićenih pasmina i sojeva domaćih životinja te njihov potrebiti broj. N.N. 39/06.

Narodne novine 2009. Izmjena popisa izvornih i zaštićenih pasmina i sojeva domaćih životinja te njihov potrebiti broj. N.N. 70/09.

Pavičić M., 2011. Tradicija u očuvanju bioraznolikosti poplavnih pašnjaka uz Savu. Hrvatska vodoprivreda, 19: 77-79.

Mobile application for twelve Slovenian autochthonous breeds

Daša Jevšinek Skok, Danijela Bojkovski

University of Ljubljana, Biotechnical Faculty, Department of Animal Science, Groblje 3, SI-1230 Domžale, Slovenia

ABSTRACT

In Slovenia, we have 12 autochthonous farm animal breeds. Raising awareness and promoting of these breeds is one of the main objectives of the National program on farm animal genetic resources conservation. In order to achieve better promotion of these breeds, we developed a mobile application that briefly represents the 12 Slovenian autochthonous breeds: four sheep breeds, one goat, hen, bee, cattle, pig and three horse breeds. Application contains direct links to the website of Public Service for Farm Animal Genetic Resources Preservation (http://www.genska-banka.si/), where all details are available. In addition, all significant contacts are available for simple communication between application user and staff. Mobile application for the Android based smartphones, was developed using MIT APP Inventor (http://appinventor.mit.edu/explore/). The application is available in two languages: Slovenian and English. It contains five screens named “Home”, “About us”, “Breeds”, and “Share app”. The developed application provides a quick overview of Public Service’s work and 12 Slovenian autochthonous breeds.

Keywords: mobile application, farm animals, Slovenian autochthonous breeds

INTRODUCTION

The autochthonous breeds have an essential role in preserving biodiversity as well as to ensure food for current and future generations. An important part of biodiversity is agricultural biodiversity, namely the conservation of farm animal genetic resources. In 2010, The Public Service for Farm Animal Genetic Resources Preservation (hereinafter Public Service) was appointed, to lead the work in this field. Conservation of the Slovenian farm animal genetic resources and especially autochthonous Slovenian breeds is the main task of the Public service. At the present state, in Slovenia we keep 12 autochthonous farm animal breeds. From the total number of the autochthonous breeds we keep four sheep breeds, one goat, hen, bee, cattle, pig and three horse breeds. There are four autochthonous sheep breeds kept in Slovenia: Istrian Pramenka, Bela Krajina Pramenka, Jezersko-Solcava sheep and Bovec sheep. The Istrian Pramenka is a dairy breed used for milk and lamb production. The breed originated in region Karst and Istria (Istrska pramenka …, 2012). Bela Krajina Pramenka is widespread in the southeast part of Slovenia near the river Kolpa and is used for lamb production. Due to their exceptional adaptability to poor conditions, undemanding husbandry and excellent meat quality the breed is well appreciated by the local breeders (Belokranjska Pramenka…, 2012). Jezersko-Solčava sheep is the most numerous and widespread autochthonous sheep breed in Slovenia, and is used for meat production. It originates in the region of Jezersko and Solcava, however it is geographically distributed at all parts of the country (Jezersko-Solčavska ovca…, 2012). Bovec sheep is a dual purpose bred used for milk and lamb production. The breed is named after the town Bovec, located in the upper valley of Soča river. In the Trenta valley it is also called »Trentarka«. Due to its exceptional adaptability, the Bovec sheep is spread to the other regions of Slovenia (Bovška ovca…, 2012). In addition, sheep are not the only autochthonous species among small ruminants. The Dreznica goat is the only autochthonous goat breed in Slovenia. According to the purpose of breeding and its original location, two types of Dreznica goat were formed: dairy type was developed in Bovec area, while the meat type in Dreznica region (Drežniška koza…, 2012). Cika cattle is the only autochthonous cattle breed in Slovenia. It originates from Alpine region (Kamnik, Bohinj), which are known as Alpine dairy farming. The breed is extraordinarily adapted to the steep mountain pastures. The special feature of Cika cattle is a relatively high milk yield, according to its body weight (Cikasto govedo…, 2012). The only Slovenian autochthonous pig breed, named Krškopolje pig, is known for its white belt over shoulder, according to which it is also named black-belted pig. It originates from the southeast part of Dolenjska region, the area of Krško-Brežiško field and in the foothills of Gorjanci hills. The breed is adapted to poor breeding environment and excellent for the outside grazing. It has large appetite, great ability to produce fat, good meat quality, good resistance, good maternal traits, and moderate fertility traits. The meat is tasty, due to the high content of intramuscular fat. It is suitable for roasted pork or processing into traditional dried products such as salami, sausages, and dried hams (Krškopoljski prašič…, 2012). The Styrian hen is the only autochthonous hen breed in Slovenia. It is regarded as a family-farmyard hen according to its breed characteristics. It originates in the region between the rivers Mura and Sava in the Styria region. In the past a few color variants of the Styrian hen appeared: light brown, white, barred and partridge-colored. The light brown type was the most known, and the less regular were white and barred type. Today mostly partridge-colored Styrian hens are present in

Slovenia. Nevertheless, recently the white variety has emerged, too (Štajerska kokoš…, 2012). Additionally, three autochthonous horse breed can be found in Slovenia of which, the Lipizzan horse is the most popular. It is one of the oldest cultural horse breeds in the world. The name came from Lipica, the place of the breed's origin. Lipica is located in the Slovene Karst region. It is a well settled breed and its particularities are late maturity, longevity, modesty and endurance (Lipicanski konj…, 2012). The Slovenian Cold-Blooded horse originates from the northeastern part of Slovenia and from the Gorenjska region and is based on the local Cold-Blooded horses. Nowadays, the breed is spread throughout Slovenia (Slovenski hladnokrvni konj…, 2012). The Posavje horse based on improvement of local autochthonous horse. The breed was named according to Posavje, the place of the breed's origin (Posavski konj…, 2012). The last but not least Slovenian autochthonous race of honey bee is the Carniolan bee. The Carniolan bee has developed in a wide area of Eastern Alps and High Tours, all the way to the Karpati Mountains, and to the North part of Macedonia. Due to the bee trade, the Carniolan bee is well widespread on all continents. In Slovenia, there are about 30 registered queen breeders and around 150,000 colonies of Carniolan bee (Kranjska čebela…, 2012).

Autochthonous breeds in Slovenia are not sufficiently recognizable to the wider public. Due to increasing different information on the web, users have a difficult task to extract the most reliable information. Mobile technology has already become a part of our daily life and presents another source of information. On the other hand, the development of mobile technologies provides the opportunity to serve information closer to the user. For this reason, the aim was to developed the mobile application and to present the 12 autochthonous breeds from Slovenia.

MATERIALS AND METHODS

Mobile application for the Android based smartphones, was developed using MIT APP Inventor (http://appinventor.mit.edu/) (Schiller et al., 2013). It presents the total of 12 Slovenian autochthonous breeds of farm animals: Istrian Pramenka, Bela Krajina Pramenka, Jezersko-Solčava sheep, Bovec sheep, Styrian hen, Carniolan bee, Posavje horse, Lipizzan horse, Drežnica goat, Slovenian Cold-Blooded horse, Krškopolje pig, and Cika cattle. The descriptions of all breeds presented on the Mobile Application were extracted from the website of Public Service (http://www.genska-banka.si/).

RESULTS

The mobile application was developed for raising awareness and better promotion of Slovenian autochthonous breeds and Public Services work. Developed application contains basic description of Public Service and 12 Slovenian autochthonous breeds. For more details, direct links to the website of Public Service (http://www.genska-banka.si/) is added. The application is available in two languages: Slovenian and English. The homepage screen of the application contains language button and connection to five screens named "Home" (slo. Domov), "About us" (slo. O nas), "Breeds" (slo. Pasme), and "Share app" (slo. Deli aplikacijo) (Figure 1).

Figure 1: Homepage screen of the application for 12 Slovenian autochthonous breeds

The "Home" screen is designed for the presentation of Public Service and its work. The screen named "About us" contains hyperlink to the webpage of Public Service, email address and authorship information. The central screen named "Breeds" presents 12 Slovenian autochthonous breeds. Using button click option of the picture, a pop up screen gives you a short breed description. For more details, user can click on the button named "More about Slovenian Autochthonous Breeds" and download the publications written by Public Service (Figure 2).

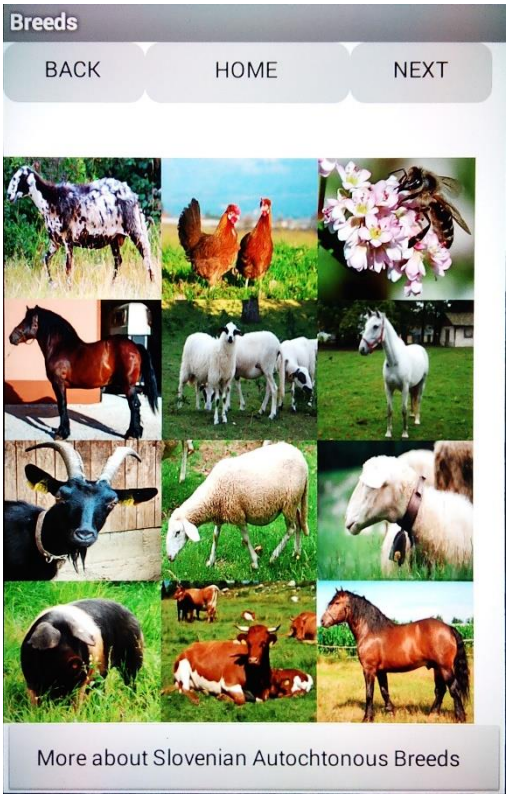

Figure 2: Screen of mobile application for 12 Slovenian autochthonous breeds

Mobile application is freely available through QR code (Figure 3) or direct download .apk file on Public Service website (http://www.genska-banka.si/mobile-application/), MIT App Inventor's Integrated Gallery.

Figure 3: Screen with Quick Response Code (QR Code) for mobile application download

CONCLUSION

Public Service observes the implementation of biodiversity of farm animals education and in training on secondary agricultural schools, agricultural colleges and high schools, and the undergraduate and graduate levels. For the expert public, recognized breeding organizations and professional workshop lectures on the state of biodiversity in farm animals, and other topics related to biodiversity in animal husbandry are organized by the Public Service each year. For the purpose of raising awareness and informing, they prepare various promotional material such as calendars and leaflets, as well as organize meetings and fairs. In addition, Public Service's homepage is regularly updated. Mobile application was developed as promotional material, where information are available almost everywhere. It will contribute to the promotion and visibility of the Public Service's work, and provides a short review of 12 Slovenian autochthonous breeds. The regular updates of the mobile content are necessary in order to continually improve the quality of the mobile application. In the future work, we intend to expand the mobile application adding new contents and links.

REFERENCES

Belokranjska pramenka: slovenska avtohtona pasma ovc. 2012. Domžale, Javna služba nalog genske banke v živinoreji, Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za zootehniko, 6 pages.

Bovška ovca: slovenska avtohtona pasma ovc. 2012. Domžale, Javna služba nalog genske banke v živinoreji, Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za zootehniko, 6 pages.

Cikasto govedo: slovenska avtohtona pasma goveda. 2012. Domžale, Javna služba nalog genske banke v živinoreji, Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za zootehniko, 6 pages.

Drežniška koza: slovenska avtohtona pasma koz. 2012. Domžale, Javna služba nalog genske banke v živinoreji, Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za zootehniko, 6 pages.

Istrska pramenka: slovenska avtohtona pasma ovc. 2012. Domžale, Javna služba nalog genske banke v živinoreji, Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za zootehniko, 6 pages.

Jezersko-solčavska ovca: slovenska avtohtona pasma ovc. 2012. Domžale, Javna služba nalog genske banke v živinoreji, Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za zootehniko, 6 pages.

Kranjska čebela: slovenska avtohtona podvrsta medonosne čebele. 2012. Domžale, Javna služba nalog genske banke v živinoreji, Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za zootehniko, 6 pages.

Krškopoljski prašič: slovenska avtohtona pasma prašičev. 2012. Domžale, Javna služba nalog genske banke v živinoreji, Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za zootehniko, 6 pages.

Lipicanski konj: slovenska avtohtona pasma konj. 2012. Domžale, Javna služba nalog genske banke v živinoreji, Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za zootehniko, 6 pages.

Posavski konj: slovenska avtohtona pasma konj. 2012. Domžale, Javna služba nalog genske banke v živinoreji, Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za zootehniko, 6 pages.

Public Service for farm animal genetic resources preservation. 2010. Domžale, Javna služba nalog genske banke v živinoreji, Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za zootehniko, 6 pages.

Schiller, Jeffrey, Andrew Mckinney, Franklyn Turbak, and Mark Friedman. 2013. "Live Programming of Mobile Apps in App Inventor."

Slovenski hladnokrvni konj: slovenska avtohtona pasma konj. 2012. Domžale, Javna služba nalog genske banke v živinoreji, Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za zootehniko, 6 pages.

Štajerska kokoš: slovenska avtohtona pasma kokoši. 2012. Domžale, Javna služba nalog genske banke v živinoreji, Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za zootehniko, 6 pages.

Evaluation of Hucul horse strains

Enikő Somogyvári, János Posta, Georgina Hardon, Sándor Mihók

University of Debrecen, Faculty of Agricultural and Food Sciences and Environmental Management, Institute of Animal Science, Biotechnology and Nature Conservation, Department of Animal Breeding

ABSTRACT

During the evaluation of the genealogical lines of the Hucul breed, it can be concluded that most animals belong to the Polish breeders with large differences among the strains. The most important strains are Gurgul, Hroby and Pietrosu in Poland. Goral stallions are equally distributed among Romania, Slovakia and Poland though there are also some in Hungary, Czech Republic and Austria. All the strains were founded by a single stallion, and the breeding continued mostly with only one or two animals in the first three-four generation of the breeding history. Decreasing of the genetic diversity could be recognized in the initial period of the breeding. After the fourth and fifth generation, more stallions were used in the breeding stock than it is reasonable due to successful importing/exporting of breeding animals. E.g.: Pietrosu VI-111 Lu was exported to Poland and used as Pietrosu V Pl, or Cukor Gurgul was sold from Slovakia to Poland where most of the stallions are the descendant of this stallion. Exchanging of the breeding stock is continuous among the countries, though with different tendencies among the strains, and not all the strains appear in all countries with breeding stock of the breed under gene conversation.

The various strains are from the 9-10th generations from the founder stallions, except Ousor, which is only at the seventh generation.

Keywords: genetic diversity, genetic relationship, Hucul, stallions

INTRODUCTION

The aim of the study was to explore the genealogical lines, to describe the genetic relationship between breeder countries and to calculate the number of generations between the founder and the presently active breeding stallions based on the strains of the protected and endangered Hucul horse breed. This work could give information about the direction of the genetic diversity and identifies the extinct genealogical parts of the strains. The research study also gives information about how different countries take part in the preservation of the breed and the gene flow of the breeding stock can also be followed. The genetic variability within population and the knowledge of the direction of the gene flow are necessary to the development of a proper selection programme fitted to the present breeding stock.

MATERIAL AND METHODS

The present study was carried out using the paper-based and/or online stud-books of the breeding organizations of countries breeding Hucul horses such as Slovakia (Národný Žrebčin Topoľčianky, 1996, 2001, 2007), Chech Republic (Asociace chovatelů huculského koně, 2004), Poland (Polski Związek Hodowców Koni, 2004), Hungary (Mihók, 2014; Mihók and Németh, 2013; Póni és Kislótenyésztők Országos Egyesülete, 2011) and Romania (Lechkun, 2008; Rădulescu, 1957). The analysed date period is from the 1890s up to 2014 for the seven strains of the breed.

RESULTS

The founder stallion **Goral** was born in 1898. Goral was bought in Halics and started his breeder career before the First World War and left five male progeny for breeding. Some of them – as well as their offspring – were used in the Polish, -Czech and Hungarian breeding, while Goral-13 (as Goral I) was used in Romania. At the fourth generation of the strain, only this part of the stock survived, the others went extinct both in Hungary, Poland and the Czech Republic. The growth of the strain was Goral – Goral I – Goral III– Goral V, with 1-1 breeding stallion in each generation. Goral V left five stallions for breed. Though Goral III's stallion progeny, Goral IV continued the line with Goral VIII, he couldn't leave any offspring for the line, so this part of the strain also went extinct at that stage. Goral V's two breeding stallion offspring, Goral VII and Goral IX are the ancestors of all presently living Goral horses. Their descendants are equally distributed among Romania, Slovakia and Poland. There are also some Goral horses in Hungary, the Czech Republic and Austria. There is no noticeable gene loss after the fourth generation in the Goral strain. The recent Polish breeding stock of the Goral strain is originated from stallions bought in the 1960's and 1970's from Topoľčianky (Goral X Top = Go. 3 Pl) and Lucina (Goral XIII-4 Lu= Go. 6 Pl). Both stallions were – favourably – used –almost equally in the breeding. The stallion Goral Rygor (8th generation) appearing with a lot of progenies gives rise to concern but it seems his progenies have only a few offspring contributing to the 10th generation. The Goral XVI breeding stallion, (born in Lucina), progenies were imported both to Hungary and Topoľčianky and had great relevance and flew the strain into the 8th and 9th generation. The migration within the Goral strain is continuous. There were several successful exchanges - regarding Lucina – Hungary, Poland – Austria – Hungary. The Goral strain is a successful example of genetic diversity as there are quality breeding animals of the strain in each breeding countries. The gene flow appears in the 8th generation in the following

routes: from Lucina to Topoľčianky, from Topoľčianky to the Czech Republic and Austria, from Austria to Hungary.

Table 1: Number of breeding stallions within Hucul strains per generation *

Founder of the strain (birth date)	**Generation**									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Goral (1898)	7/1	15/6	22/7	15/6	5/4	11/3	19/6	23/7	40/13	7/5
Hroby (1895)	4/1	9/3	13/5	8/4	14/6	22/8	45/10	37/14	2/2	
Prislop (1932)	1/1	1/1	1/1	3/1	2/2	1/1	5/1	11/3	3/3	2/1
Pietrosu (1930)	2/1	2/1	3/2	2/1	4/2	5/2	18/2	20/5	4/3	
Ousor (1933)	3/1	3/2	5/2	10/4	13/5	21/6	12/8			
Polan (1929)	1/1	2/1	3/1	2/1	7/2	8/3	5/2			
Gurgul (1927)	4/1	2/2	5/2	26/5	12/5	41/6	41/18	10/5		

*: number of breeding stallions / number of sires of breeding stallions

The **Hroby**, born in 1895 and originated from Bukovina, is one of the two stallions surviving the First World War, so can be - considered as classical stallion strain of the Hucul breed. Because of the 152 breeding stallions within the strain, the Hroby strain is the largest based on the number of breeding animals. It appears in all breeder countries, with largest sub-populations in Romania and Poland. Among the four progenies in the first generation, only Hroby I Rad = Hroby I Top (born in Radautz and breed in Topoľčianky) had determinative effect on the breed. The Hroby strain survived only through this stallion! There were 9 breeding stallions in the 2nd generation, but only 5 of them had progenies in the upcoming generation (Table 1.). A stallion from this line (Hroby I-4 Rad. Pl.) was used in Poland in the second part of the 1920's, but the present Polish stock are not descendants of this stallion. From the 3rd generation, Hroby VIII and Hroby V from Lucina and Hroby IV from Topoľčianky had a determinative effect on the strain. Hroby II had only a single progeny in breeding in the 6th generation and this part of the strain became extinct soon. Hroby XVII, the great-grandchild of Hroby V, was used as breeding stallion in Topoľčianky as Hroby VII carried on the strain in generations in Romania and had several progenies in Slovakia, Poland and the Czech Republic. Hroby IV was also a determinative stallion of the strain, having a lot of progenies in Romania, Poland, the Czech Republic, Hungary and Slovakia. This stallion was the grandfather of Hroby V-22 which was bought by Polish breeders and used as Hroby 4 Pl in Poland and 75% of the Polish Hroby strain is originated from this stallion. His son, Hroby Dioryt had the main influence on the genetic structure of the Polish stock, which can be dangerous due to the loss of genetic variety and biodiversity. These stallions were responsible for the expansion of the strain in the 7th and 8th generations. There were only a few stallions in the 9th generation after the above mentioned lot of progenies while horses in the 7th and 8th generations are nearly 15 years old. The genetic migration is quite small from the Polish stock. 2-2 stallions were exported for breeding to Hungary and Austria, respectively. The Hroby strain appears through more parts of the genealogical line in the Romanian breeding. There were animals imported for breeding from both parts to Slovakia, Hungary, Poland and the Czech Republic. Hroby XVI-62 (later named as Hroby XXI as breeding stallion), appearing in the 6th generation, had large breeding effect

on the Romanian breeding. Progenies of this stallion appeared in the breeding of all breeder countries. Sons of the stallions were favourably used in the Slovakian and Polish breeding, respectively.

The **Prislop** strain goes back to the Goral. The founder stallion was born in 1932 in the Lucina region, his father was Goral I-7. Later this stallion developed a different part of the ancient strain and founded a new one. There was only 1-1 breeding stallion in the breeding of Lucina in the first three generations (Table 1). There was an unsuccessful trial to expand the strain in the 4th generation with three stallions, it was achieved only in the 7th and 8th generations. It is unlikely from genetic biodiversity of the strain that all animals of the present population are descendants of Prislop IX, born in 1978. The genetic material of the other stallions was lost for the breeding. This genealogical line began to expand in the 7th generation with four sons of Prislop IX, and their progenies appearing also in the nearby countries. Prislop IX-90 (born in 1985) moved as young colt to the Topoľčianky Natonal Stud and was used under the name 7 Prislop Top as breeding stallion. He also acted as breeding stallion in the Aggtelek National Park in Jósvafő and gave a quality stallion to the Hungarian breeding. The colt numbered Prislop IX-81 became a successful breeding stallion under the name Prislop 8 in Poland, six of his progenies were used as breeding stallions, some of them were used in the Czech Republic. Prislop Luzifer, born in Lucina, was used as breeding stallion in Austria and also in Poland. There is no information about breeding stallion progenies of this stallion yet. Prislop IX-47 (as Prislop X breeding stallion) had great influence on the breeding in Lucina, and one of his progenies (Prislop X-35 Prímás) was used in the Hungarian breeding as well. There is a grandson of Prislop X also in Poland (Prislop Puchacz Pl), whose progenies lead the history of the strain to the 10th generation with two breeding stallions. These facts expanded the places and countries of the strain where it is present. It seems that the strain has breeding stallions in the 10th generation only in Poland.

Pietrosu was born in 1930. Stallions of the first five generations of the strain were bred in Lucina and one stallion was exported to Poland. Twothird of the 61 used breeding stallions up to 2014 originated from Polish breeding. The Pietrosu strain mostly appears in Poland. The founder stallion had two breeding stallion progenies, but only Pietrosu II Lu took further the strain with two progenies. Pietrosu V Lu had only one offspring in the breeding, Pietrosu VII Lu, but unfortunately this stallion left no further breeding stallion progenies and this part of the strain was lost for breeding. Pietrosu II Lu had three grandchildren in the third generation, but only one of them had stallion progenies. Pietrosu VI-111 Lu, born in the fourth generation, was the founder of the Polish part of the strain under the name of Pietrosu 5 Pl. Most part of the present population of the strain originated from this breeding stallion, so he had a great impact on the genetic structure of the later population of the strain. Pietrosu Piaf is the stallion with largest influence of the strain with 16 progenies selected as breeding stallions. This resulted in the sudden expand of the strain in the seventh generation up to 18 stallions. This might be not favourable when the rules of gene preservation were taken into account as it decreases the genetic diversity. Two sons of Pietrosu Piaf had great impact on the Polish Hucul population: Pietrosu Baca (11 breeding stallion progenies) and Pietrosu Szwed (5 breeding stallion progenies in the 8th generation where there are 20 animals in total). Despite the above mentioned fact, the ninth generation of the strain seems to be narrow. Among the 16 progenies of Pietrosu Piaf 16, Pietrosu Jadeit Pl got breeding licence not only in Poland, but both in Austria and

Hungary. He has progenies in each country. The Lucina stock went further through the line of Pietrosu VIII Lu. He had only one progeny in the 5th and 6th, and two descendants in the 7th and 8th generations, respectively. Pietrosu XI-14 Magura Lu-Hu and Pietrosu Pákó arrived in the Hungarian breeding stock from this line in the 9th generation of the strain.

Wendling, the head of the Lucina Stud, found the stallion **Ousor** (born in 1929) which was the founder of another strain in Lucina. There were three breeding stallions after the founder in the 1st generation, Ousor I, Ousor II and Ousor-5. The last one gave several stallion progenies to Topoľčianky through the Murany stock and one of his sons, Ousor I Top, was exported to Poland and was associated with the name Ousor 7 Pl in the Polish breeding. The descendants of this stallion had extended the Polish Hucul breeding through three generations as it gave 15 stallions to enhance the Ousor strain in Poland. The same part of the strain is also present in the Czech Republic by Ousor-3 Úver Top. Unfortunately, the Czech part of the strain went extinct in the 6th generation with the breeding stallion Bandita, born in 1996. The present stock after the Ousor-5 stallion is almost equally distributed between the Slovakian and Polish breeding. The other part of the Ousor strain also had several breeding stallions in Lucina after the Ousor II Lu and mainly the sons (Ousor VI és Ousor VII) of Ousor IV. The Ousor VI-61 (with the name Ousor VIII Lu in the Romanian breeding) was used also in Hungary and gave a broodmare for the breeding. A son of Ousor VIII was sold to the Czech Republic through the Topoľčianky Stud and had descendants in the Czechish breeding. Another son, Ousor VIII-50 was exported to Poland and was used in the Polish breeding under the name Ousor 10 Pl. There are several breeding stallions after this horse in the Polish population in the 7th and 8th generation of the strain. Ousor VII was the father of possibly the most beautiful Ousor stallion known as Ousor IX. Among the progenies of this breeding stallion, Ousor IX-17 began his breeding career in the Hungarian breeding and later was exchanged for a stallion from the Prislop strain with the Topoľčianky Stud and was used under the name Ousor V Top for three breeding seasons in Slovakia. One of his sons was registered in Topoľčianky as Ousor VIII and there are also several breeding stallion sons in Hungary. Later, Ousor IX-17 and his son, Ousor Zebulon, were exported to the Czech Republic, so the strain is also presented in that country. The Ousor strain is in its 7th generation from the founder in 2014 and Ousor stallions are equally distributed among Romania, Slovakia and Poland. The strain is of the same age as other young strains founded in the beginning of the 20th century but has lived only seven generations so far as opposed to the others in their 9th and 10th, respectively.

The founder stallion of the **Polan** strain was born in 1929 and originated from Polish folksy breeding. In the first few generations, usually one or two progenies were kept in the breeding and only one of them could carry on the strain. Polan Orzech Pl rose among the others as three breeding stallions were used for breeding after him in the 3rd generation of the strain. Only Polan Afekt Pl was outstandingly valuable among his progenies as he is the ancestor of all presently living stallions of the Polan strain. Two of his progenies were used as breeding stallion, one of them; Polan Luzak gave 6 stallions for the breeding. From these 6 progenies, Polan Rapsod was sold to Hungary as young stallion and gave a lot of broodmares to the breeding stock of the Aggtelek National Park. There were no valuable stallion progenies descending from him in Poland, so the Polish breeders bought one of his sons, which was born in Hungary. This stallion was Polan Pamacs Hu (born in 2000, dam: Ousor VIII-20 Anett) and had 4 stallion progenies in Poland. There is only one stallion (Polan Pallos) from this strain in

Hungary currently. Unfortunately, this stallion could moderately pass on his genetic merit as he has only a few broodmare progenies. Polan Len Pl is an important progeny of Polan Luzak as he had five selected sons for breeding. There are some members of the Polan strain also in Austria. The progeny of Polan Princzer, Polan Polo Au is a breeding stallion in Austria and has a selected son (Polan Prince of Darkness Au) in the 7th generation of the history of the strain. From the founder up to 2014, there were 31 stallions selected for breeding from this strain.

Gurgul was born in 1924, in the former Huculland region, in Czechoslovakia. Two sons of the founder stallion started to build this strain from generation to generation. The breeding could go further through Gurgul-3 (born in 1932) and Gurgul I (born in 1933). Later descendants of the first stallion were splitted between Czech and Slovakian breeding separated 25 years ago. The breeding stallion Gurgul XI Céló, from the 7th generation of the strain, appeared in the Hungarian breeding in the autumn of 2014. Formerly, the Czech Gurgul XII was also used in the Hungarian breeding under the name Gurgul Castor. The last stallion from the Gurgul I genealogical line in Czechoslovakia was Cukor Gurgul-5 born in 1953 in Murany - which was exported to Poland and all living stallions from the Gurgul strain in Poland are the descendants of him. The strain is in the 8th generation in Poland and became the largest compared to the others. There were 14 breeding stallion progenies of Cukor Gurgul, but only two of them could go on the strain. Presently the grandchildren and great-grandchildren of Gurgul Zefir (in the 4th generation of the strain) dominate the Polish part of the strain. Gurgul Jasmin from the 5th generation of the strain has to be mentioned as 26 breeding stallions were selected among his progenies. There are 25 grandsons after his 13 sons in the breeding currently. Despite of all his excellence, his act in the breeding had negative effect on the genetic diversity of the breed. Further 12 Gurgul stallions are the great-grandsons of Gurgul Zefir. They were born after Gurgul Puszczyk, the son of Gurgul Zefir. The Gurgul strain, originating from Czechslovakia, is an icon of the Polish Hucul breeding and the number of stallions in breeding in Poland is much higher than that of the other countries. Hungary and Austria breed this strain only as a small part of their Hucul population. There are also only some quality breeding stallions from this strain in the Czech Republic.

DISCUSSION AND CONCLUSIONS

In summary, the largest part of the population belongs to Poland but is unequally distributed among the different strains. Poland plays a decisive role in the breeding of Gurgul, Hroby and Pietrosu strains. The distribution of the strains in the countries is different. In the case of the Goral strain, the distribution is equal in Romania, Slovakia and Poland, though there are Goral horses also in Hungary, the Czech Republic and Austria. Most of the strains go back only to one or two ancestors like Pietrosu VI-111 Lu, Pietrosu 5 Pl and they had similar amount of offsprings in the population like Goral X Top = Go. 3 Pl and Goral XIII-4 Lu= Go. 6 Pl. The flow of the breeding stock among countries is continuous, though there are large differences between the strains. The various strains are from the 9-10th generations from the founder stallions, except for the young Ousor strains which is already at the seventh generation.

REFERENCES

Asociace chovatelů huculského koně. 2002. Plemenná kniha huculského koně ČR.

Lechkun M. 2008. Méntörzsek Romániában. Kézirat.

Mihók S. 2014. A hucul. Budapest, Mezőgazda Kiadó.

Mihók S., Németh Z. 2013. Génmegőrzés készségvizsgák sportolva, szórakozva. Debrecen, Póni- és Kislótenyésztők Országos Egyesülete.

Národný Žrebčin Topoľčianky. 1996. Plemenná Kniha Huculských Koní, Zväzok II 1985-1995.

Národný Žrebčin s. p. Topoľčianky. 2001. Plemenná Kniha Huculských Koní, 1995-2001.

Národný Žrebčin s. p. Topoľčianky. 2007. Plemenná Kniha Huculských Koní, 2002-2007.

Póni és Kislótenyésztők Országos Egyesülete. 2011. Hucul Méneskönyv I-II-III. kötet.

Polski Związek Hodowców Koni. 2004. Księga stadna koni rasy huculskiej Tom VIII.

Rădulescu G. H. 1957. Calul huţul din R. P. R. Editura Agro-Silvică de Stat, Bucureşti.