Chapter

Black Slavonian (Crna slavonska) Pig

Vladimir Margeta, Kristina Gvozdanović, Goran Kušec, Ivona Djurkin Kušec and Nina Batorek-Lukač

Abstract

Black Slavonian (Crna slavonska) pig was created during the second part of the nineteenth century using planned crossing between four pig breeds. It is an autochthonous pig breed in the Republic of Croatia and one of the local pig breeds investigated in the project TREASURE. The present chapter aims to present history and current status of Black Slavonian pig breed, its exterior phenotypic characteristics, reproductive traits, geographical location, production system and main products from this breed of pigs. Also, a collection and review of available literature data, available until August 2017, on productive traits of Black Slavonian pig breed were carried out. Growth performance was estimated utilising average daily gain and average daily feed intake in the overall fattening stage as this was the information mostly provided in considered studies. Carcass traits were evaluated by means of age and weight at slaughter, hot carcass weight, carcass yield, muscularity and back fat thickness. Meat quality traits of the longissimus muscle evaluated were objective colour and intramuscular fat content. Although a considerable number of studies on Black Slavonian pig were included in the current review, data on growth performance and some parameters of carcass, meat and fat quality are scarce.

Keywords: traditional European breed, TREASURE, productive traits, phenotype, Croatia

1. History and current status of the breed (census)

Black Slavonian (Crna slavonska) pig is an autochthonous pig breed in the Republic of Croatia. It was created during the second part of the nineteenth century on the estate of Count Pfeifer, Orlovnjak, near Osijek. It is also known by the name "Fajferica". It is a result of planned crossing between four pig breeds: Mangalitsa, Berkshire, Poland China and Large Black pig. This crossing aimed to create a pig with better meat and fertility traits. The first phase of crossing includes ten gilts of Mangalitsa and Berkshire boars. Additionally, Poland China boars were included in crossing schemes every 10 years. These systematic crossings were carried out from 1870 to 1910 [1]. The final phase of creation of Black Slavonian breed was during 1920 when crossing with English black breed-large black occurred. The success of crossing and breeding was confirmed in 1873 by winning gold medals at the Vienna Agricultural Fair [2]. At the end of the nineteenth and early twentieth centuries, Black Slavonian pig was the most common and, from an economic standpoint, the

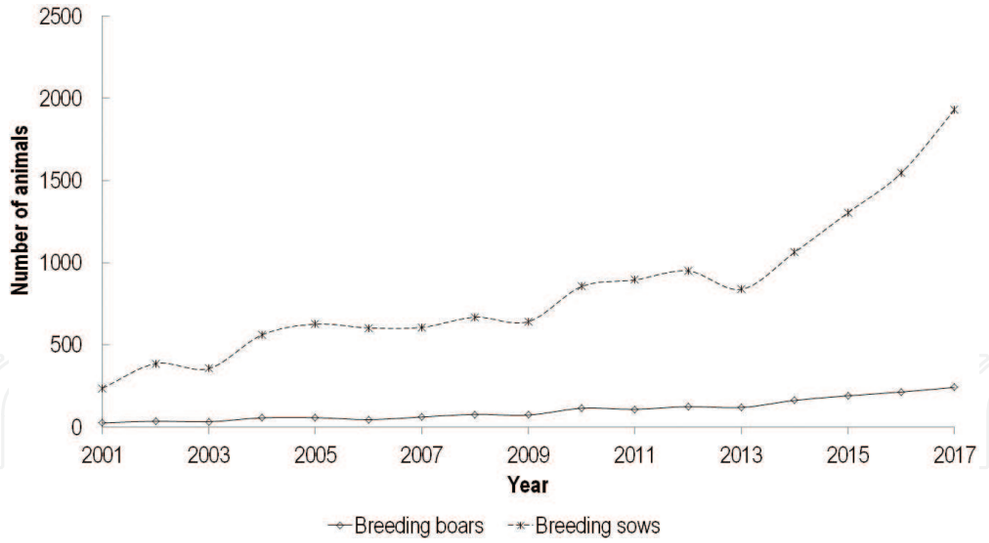

Figure 1.
Census of Black Slavonian pig breed, presenting number of sows and boars per year.

most important pig in what is now eastern Croatia. Thus, it is nowadays rightly considered an indigenous breed. Census of Black Slavonian pig breed is presented in **Figure 1**. Presently there about 209 registered farms with 1930 breeding sows and 242 boars of Black Slavonian pig breed in the latest available status ([3], December 2017).

2. Exterior phenotypic characteristics

The Black Slavonian pig breed morphology information is summarised in **Table 1**. By morphological characteristics, Black Slavonian pig breed is similar to Mangalitsa, although regarding physiological characteristics it is more similar to the Berkshire and Poland China pig breed. The most important characteristic of Black Slavonian pig breed is its black coat colour. The peas and snout are also dark. Black Slavonian pig is a medium-sized pig. The height of the ridge is 65 to 70 cm. The head is medium long with a dense profile and with medium-sized and semi-circular drooping ears. The muscular neck is medium wide and medium in length. The chest is deep and wide. The body and legs are relatively short, whereas the hips are wide and fallen [3] (**Figures 2** and **3**).

Measurement (average)	**Adult male**	**Adult female**
Body weight (kg)	250	200
Body length[1] (cm)	130	120
Head length (cm)	50	50
Tail length (cm)	30	30
Ear length	Large	Large
Chest girth (cm)	110	100
Height at withers (cm)	75	70
Number of teats	10–14	10–14
Other specific visible traits		
Hair	Curly, straight, short, long	
Tusks	Present	

Measurement (average)	Adult male	Adult female
Snout	Long and thin	
Coat colour pattern	Plain	
Coat colour type	Black	
Head profile	Concave	
Ear type	Droopy (pendulous)	
Ear orientation	Project forwards	
Skin	Smooth	
Tail type	Straight, curly (kinked)	
Backline	Straight, swaybacked	

[1]*Measured from the tip of the nose to the starting point of the tail.*

Table 1.
Summary of morphology information on Black Slavonian pig breed.

Figure 2.
Black Slavonian sow with piglets.

Figure 3.
Black Slavonian boar.

3. Geographical location and production system

Black Slavonian pig is bred in the area of Slavonian counties: Brodsko-Posavska, Požeško-Slavonska, Osječko-Baranjske and Vukovarsko-Srijemska. Today the Black Slavonian pig is bred, also, in the area of Sisak-Moslavačka County. Black Slavonian pig breed is suitable for keeping under extensive, intensive and semi-intensive conditions. Breeding under semi-intensive conditions is the traditional production system for Black Slavonian pig [4, 5]. In this system, pigs are kept in pastures and woods where they exploit the food they find. On 1 ha of pasture area, 15 to 20 sows can be reared, depending on available nutrition and amount of the soil. To emphasise the traditional meaning of Black Slavonian pig, it is advisable to build facilities in a traditional style typical for the breeding area. Facilities for gilts and sows should be semi-open object (30 m^2). Size of farrowing pen should be at least 6 × 1.5 m. After the farrowing, piglets should be placed together. Fattening period is a final stage of production system. This period must last at least 18 months and during this period pigs can reach from 130 to 150 kg [6]. Under extensive rearing conditions, pigs are kept on pastures where all the food is available to the pigs. The basis of nutrition in the system is acorn with additional feeding during the winter period [7]. Exceptionally before farrowing, sows are placed in semi-open facilities whose floors are filled up with straw. Sows and piglets in such facilities remain until weaning [2].

4. Organisations for breeding, monitoring and conservation

The conservation and breeding programme began in 1994 and is carried out by the Croatian Agricultural Agency (Hrvatska poljoprivredna agencija, HPA). The agency is in charge of keeping the register, marking the pigs and assessing the breeding value of breeding male and female animals. Monetary funds support the breeding of Black Slavonian pigs (150 EUR per year per breeding animal). The pedigree issuance is carried out in cooperation with the association of breeders of Black Slavonian pig "Fajferica", which is also responsible for the implementation of the breeding programme (**Table 2**).

Name of organisation	Address	Web address
Hrvatska poljoprivredna agencija/ Croatian Agricultural Agency	Ilica 101, 10,000 Zagreb, Croatia	http://www.hpa.hr/sektori/sektor-za-razvoj-stocarske-proizvodnje/odjel-za-svinjogojstvo/izvorne-pasmine/
Udruga uzgajivača crne slavonske svinje Slavonije, Baranje i zapadnog Srijema/ Association of breeders of Black Slavonian pig	Vladimira Nazora 1, 31,400 Đakovo, Croatia	www.fajferica.hr

Table 2.
Contact details of breeding organisation for Black Slavonian pig breed.

5. Productive performance

5.1 Reproductive traits

Basic data obtained on reproductive traits in this review are presented in **Table 3**. The average age of sows at first parturition is 15 months [13, 15]. According

Reference	Sow age at first parturition (mth)	Litters per sow per year	No. of piglets alive per litter	Piglet live weight (kg)	Stillborn per litter (%)	Piglet live weaning (%)	Piglet weaning weight (kg)	Duration of lactation (d)	Farrowing interval (d)
[3]	—	1.2	5.5	—	10.3	11.2	—	—	—
[8]	—	—	6.1	—	—	15.9	—	—	—
[9]	—	1.8	7.4	—	—	10.3	—	—	201
[10]	—	—	6.3	—	11.1	9.5	—	—	—
[11]	—	—	6.1	—	—	—	—	—	—
[12]	—	—	6.0	—	—	—	—	—	—
[13]	—	2.0	6.5	1.3	13.3	7.7	9.5	49	183
	15.0	2.2	—	1.3	—	—	—	—	165
[14]	—	—	6.1	—	—	—	—	—	—
[15]	14.6	—	—	1.2	—	—	11.0	56	—
[16, 17]	—	—	6.1	—	—	—	—	—	—
[17, 18]	—	1.1	6.5	—	6.8	12.4	—	—	326
[19, 20]	—	—	6.9	1.3	8.7	8.8	11.3	—	—
[21]	—	—	5.0	—	15.9	7.1	—	57	—
[22]	—	—	6.8	—	1.0	5.4	—	—	—
[23]	—	—	6.6	—	3.5	6.8	—	—	—

No. = number, mth = month, d = days.

Table 3.
Summary of collected literature data on reproduction traits in Black Slavonian pig breed.

to the collected literature, sows of Black Slavonian pig breed have 1.1 to 2.2 litters per year [3, 9, 13, 17, 18] with 5.0 to 7.4 piglets [3, 8, 9–14, 16–23] of approximately 1.3 kg live body weight [13, 15, 19, 20]. Stillborn percentage of piglets is very variable and ranges from 1.0 to 15.9% [3, 10, 13, 17–21]; similarly piglet mortality rate until weaning spans from 5.4 to 15.9% [3, 8–10, 13, 17–21]. Duration of lactation is prolonged in comparison with modern intensive systems up to 57 days [21], which leads to a longer farrowing interval (165 to 326 days [9, 13, 17, 18]) and also higher weaning weight (9.5 to 11.3 [13, 15, 19, 20]). According to Uremović et al. [8], the number of live-born piglets in litter is determined by the number of farrowings, breeding system and characteristics of the boar, while the number of weaned piglets depends on seasonality, breeding system and boar characteristics. Sows have good motherly characteristics. It can be concluded that the reproduction traits of Black Slavonian pig breed are modest, but sows have good motherly characteristics. Uremović et al. [9] suggest that increasing of fertility can be achieved by crossbreeding with Duroc.

5.2 Growth performance

Basic data on growth performance obtained in this review are presented in **Tables 4** and **5**. Due to big differences between studies with regard to the live weight range covered, we defined the stages for growth performance as lactation (regardless of how long it was), growing stage (from weaning to approximately 30 kg live body weight) and early, middle and late fattening stages estimated between approximately 30 and 60 kg, 60 and 100 kg and above 100 kg live body weight, respectively. However, in the case of Black Slavonian pig breed, studies mostly provided the overall growth rate for the whole fattening stage (defined as overall). It should also be noted that a big part of the collected studies simulated practical conditions of the production systems used and that only a smaller part of the studies aimed at evaluating the breed potential for growth. A considerably slower growth rate characterises the overall fattening stage of Black Slavonian pigs compared to modern pig breeds (approximately 335 g/day) but also by high heterogeneity among studies (189 to 567 g/day [8, 13, 15, 19, 20, 24–32]). In extensive keeping conditions, average daily gain was lower when it is compared with intensive system where pigs are fed with corn, because production system affects the average daily intake, food utilisation and pig growth rate. In the context of the evaluation of growth performance, it is also of interest to observe the extreme values, because it can be assumed that the maximum figures exhibit the growth potentials of Black Slavonian pigs in ad libitum conditions of feeding (≈ 567 g/day in the overall fattening stage). Generally, the Black Slavonian pig can achieve the final weight of 100 kg in the period of 8 months, while the weight of 170 to 200 kg can be achieved in 18 to 24 months. The food conversion in these conditions ranges from 4.5 to 5 kg.

In considered studies, the information on feed intake and feed nutritional value were scarce, which limits the evaluation of growth potential. Average daily feed intake reported ranges from 1.3 to 2.3 kg/day in the overall fattening stage [13].

5.3 Body composition and carcass traits

Basic data obtained in this review with some of the most commonly encountered carcass traits that could be compared are presented in **Table 6**. In considered studies, pigs of Black Slavonian breed were slaughtered when reaching the final age of 359 to 550 days [27, 28, 32]. The final live weight covered in the studies spans from 21 to 230 kg [8, 13, 15, 24, 27, 28, 32, 34–38] because some studies aimed to

Reference	Feeding	No. of animals	ADG lactation and growing[1]	ADG fattening[2]		
				Early and middle	Late	Overall
[8]	Rest	20	—	—	—	478
[13]	—	24	—	—	—	567
	—	24	—	—	—	509
	—	27	—	—	—	224
	—	27	—	—	—	206
	—	120	165	225	325	220
[15]	—	—	—	—	—	350
	—	—	—	—	—	550
[19, 20]	—	20	—	—	—	189
	—	20	—	—	—	211
[24]	Rest	10	—	—	—	250
[25, 26]	—	10	—	—	—	285
[27, 28]	—	10	—	—	—	376
	—	10	—	—	—	251
[29]	Rest	19	—	—	—	285
[30]	Rest	5	—	—	—	285
	Rest	5	—	—	—	285
[31]	Rest	20	—	—	—	480
[32]	Rest	30	—	—	—	245

No. = number; ADG = average daily gain in g; Rest = restrictive feeding regime.
[1]ADG in a period of lactation and growing period estimated from birth to approximately 30 kg live body weight.
[2]ADG in a period of fattening is reported for early and middle fattening stage estimated between approximately 30 and 100 kg and late fattening stage estimated above 100 kg live body weight. Sometimes the source provided only the overall growth rate for the whole studied period (in that case defined as overall).

Table 4.
Summary of collected literature data on growth performance in Black Slavonian pig breed.

Reference	No. of animals	ADFI lactation and growing[1]	ADFI fattening[2]		
			Early and middle	Late	Overall
[13]	24	—	—	—	2.3
	24	—	—	—	1.9
	27	—	—	—	2.2
	27	—	—	—	1.8
	120	0.5	1.0	1.3	1.3

No. = number, ADFI = average daily feed intake in kg/day.
[1]ADFI in a period of lactation and growing estimated from birth to approximately 30 kg live body weight.
[2]ADFI in a period of fattening is reported for early and middle fattening stage estimated between approximately 30 and 100 kg and late fattening stage estimated above 100 kg live body weight. Sometimes the source provided only the overall growth rate for the whole studied period (in that case defined as overall).

Table 5.
Summary of collected literature data on average daily feed intake (in kg/day) in Black Slavonian pig breed.

Reference	No. of animals	Final age (d)	Final BW (kg)	Hot CW (kg)	Dressing yield (%)	Lean meat content (%)	Backfat thickness (mm)		M^2 (mm)	Loin eye area (cm^2)
							S[1]	At last rib		
[8]	20	—	106	85	80.3	43.0	—	—	—	—
[13]	24	—	228	—	84.5	—	—	71	71	38
	24	—	207	—	83.6	—	—	67	72	36
	27	—	126	—	79.9	—	—	40	65	31
	27	—	116	—	80.7	—	—	32	62	34
	8	—	23	—	68.6	39.6	—	—	—	—
	8	—	21	—	66.6	38.6	—	—	—	—
	8	—	40	—	66.2	43.4	—	—	—	—
	8	—	39	—	68.8	44.1	—	—	—	—
	8	—	103	—	77.4	32.7	—	—	—	—
	8	—	84	—	71.0	40.1	—	—	—	—
	8	—	163	—	81.5	29.2	—	—	—	—
	8	—	130	—	80.7	37.6	—	—	—	—
	8	—	230	—	84.2	27.9	—	—	—	—
	8	—	207	—	83.0	28.4	—	—	—	—
	8	—	30	—	74.2	40.6	—	—	—	—
	8	—	28	—	74.1	40.2	—	—	—	—
	8	—	51	—	77.9	43.4	—	—	—	—
	8	—	41	—	78.8	43.0	—	—	—	—
	8	—	73	—	80.8	44.2	—	—	—	—
	8	—	60	—	81.7	42.8	—	—	—	—
	8	—	96	—	83.0	44.9	—	—	—	—
	8	—	83	—	82.8	41.4	—	—	—	—
	8	—	125	—	85.1	39.0	—	—	—	—
	8	—	116	—	84.1	37.3	—	—	—	—
[15]	—	—	101	81	79.8	33.0	49	51	—	27
[19, 20]	20	—	—	—	—	39.7	—	41	57	—
	20	—	—	—	—	44.1	—	34	63	—
[24]	10	—	136	112	82.4	41.0	—	50	—	33
[27, 28]	10	359	135	112	83.0	38.5	—	55	—	32
	10	540	136	112	82.4	41.0	—	50	—	33
[31]	20	—	—	116	—	—	41	—	64	—
[32]	30	550	95	78	—	—	22	—	58	—
[33]	—	—	—	79	—	32.6	—	—	—	—
[34]	16	—	110	86	77.8	47.1	—	—	—	—
	16	—	130	102	78.4	47.2	—	—	—	—

Reference	No. of animals	Final age (d)	Final BW (kg)	Hot CW (kg)	Dressing yield (%)	Lean meat content (%)	Backfat thickness (mm)		M^2 (mm)	Loin eye area (cm^2)
							S^1	At last rib		
[35–37]	16	—	130	102	78.4	—	47	—	—	—
	16	—	130	102	78.5	—	46	—	—	—
[38]	30	—	140	—	78.0	—	—	35	—	—

No. = number, BW = body weight; CW = carcass weight.
[1]M muscle thickness measured according to ZP method (at the cranial edge of the gluteus medius *muscle (mm)).*
[2]S backfat thickness measured according to ZP method (above the gluteus medius *muscle (mm)).*

Table 6.
Summary of collected literature data on body composition and carcass traits in Black Slavonian pig breed.

estimate tissue deposition rates by comparative slaughter technique [13]. Also dressing yield ranges from 66.2 to 85.1% [8, 13, 15, 24, 27, 28, 34–38] and lean meat content from 27.9 to 47.2% (SEUROP classification or dissection [8, 13, 15, 19, 20, 24, 27, 28, 33, 34]). However, when taking into consideration studies with only final body weight higher than 100 kg, dressing yield is around 81% and lean meat content around 38%. The backfat thickness values measured at the level of the last rib ranges from 32 to 71 mm [13, 15, 19, 20, 24, 27, 28, 38] and at the level of the *gluteus medius* muscle from 22 to 49 mm [15, 31, 32, 35–37]. Muscularity measured as loin eye area is between 27 and 38 cm^2 [13, 15, 24, 27, 28] and as muscle thickness at the cranial edge of the *gluteus medius* between 57 and 72 mm [13, 19, 20, 31, 32]. Comparing the proportions of fat and muscle tissue in Black Slavonian pig and modern pig breeds, it can be concluded that Black Slavonian pigs have a significantly higher proportion of fatty tissue. Karolyi et al. [26] reported that the ratio of muscle parts and fat tissue was 32% versus 27%.

5.4 Meat and fat quality

Basic data obtained in this review with some of the most commonly encountered meat quality traits measured in the *longissimus* muscle that could be found are presented in **Table 7**. In the studies reporting meat quality of Black Slavonian pigs, pH measured in the *longissimus* muscle at 45 min and 24 h *post-mortem* ranged from 6.11 to 6.75 [13, 15, 19, 20, 24–32, 34–37] and from 5.57 to 5.91 [13, 15, 19, 20, 24–30, 32, 34–37], respectively. The intramuscular fat content was highly variable, ranging from 5.0 to 12.3% [15, 24, 27, 28, 30, 33–37, 39], but in average (app. 7%) considerably higher than in modern pig breeds where this percentage is usually up to 2%. The colour measured in CIE L, a and b colour space was around 49, 16.1 and 3.3 for L, a* and b* [13, 25, 26, 29, 30, 32, 35–37, 39], respectively, demonstrating visually darker and redder colour of Black Slavonian pig breed meat. Water holding capacity, which affects the processing ability of meat, ranges from 3.98 to 4.50 cm^2 [24, 27] measured by compression method and 1.68% [32] measured by the bag method. In the considered studies, no data on the fatty acid composition was found.

6. Use of breed and main products

Black Slavonian pigs are today used for the production of piglets for sale, production of fattening pigs for fresh meat consumption and especially for the

Reference	No. of animals	pH 45	pH 24	CIE[1]			Intramuscular fat content (%)
				L*	a*	b*	
[13]	24	6.44	5.87	46	12.1	1.1	—
	24	6.44	5.91	45	9.6	0.5	—
	27	6.53	5.75	48	10.5	1.7	—
	27	6.49	5.70	47	10.9	1.7	—
[15]	—	6.75	5.62	—	—	—	7.9
[19, 20]	20	6.21	5.61	48	—	—	—
	20	6.28	6.63	54	—	—	—
[24]	10	6.60	5.80	—	—	—	5.9
[25, 26]	10	6.18	5.87	50	20.0	4.7	—
[27, 28]	10	6.60	5.70	—	—	—	5.0
	10	6.70	5.80	—	—	—	5.9
[29]	19	6.44	5.77	48	9.3	3.0	—
[30]	5	6.11	5.88	51	20.3	6.2	7.2
	5	6.25	5.86	49	19.7	3.2	6.6
[31]	20	6.32	—	—	—	—	—
[32]	30	6.41	5.78	45	19.5	3.1	—
[33]	—	—	—	—	—	—	7.9
[34]	16	6.36	5.57	51	—	—	6.8
	16	6.23	5.61	51	—	—	6.9
[35–37]	16	6.23	5.61	51	18.4	6.0	6.9
	16	6.47	5.75	48	19.3	5.5	12.3
[38]	30	6.51	—	45	—	—	—
[39]	20	6.65	5.75	48	21.6	—	5.4
	16	6.23	5.61	51	18.4	—	6.9

No. = number, pH 45 = pH measured approximately 45 minutes post-mortem*; pH 24 = pH measured approximately 24 hours* post-mortem.
[1]*CIE = objective colour defined by the Commission Internationale de l'Eclairage; L* greater value indicates a lighter colour; a* greater value indicates a redder colour; b* greater value indicates a more yellow colour.*

Table 7.
Summary of collected literature data on meat quality in Black Slavonian pig breed.

production of traditional pork products such as ham, kulen, bacon, sausage, dry cured neck and fat. More recently, the production of dry-cured ham from the Black Slavonian pigs has also begun. At present, the procedure for protection of the product "Meso crne slavonske svinje" with PDI mark is being carried out. The quality of meat and products from Black Slavonian pig has also been investigated. Results show correlations between production system and quality of smoked ham from Black Slavonian pigs; the quality was significantly better when hams were produced from pigs kept outdoors and fed with green alfalfa as the feed basis [37]. Also, the research from Karoly et al. [26] shows that Black Slavonian pigs have poorer production characteristics, but significantly improved qualitative and technological properties of meat, and that the kulen produced from Black Slavonian pigs has better quality. In the future, the production systems of Black Slavonian pigs

must be improved and harmonised. An increase in production of quality traditional value-added products is expected

Acknowledgements

The research was conducted within the project TREASURE, which has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 634476. The content of this paper reflects only the author's view, and the European Union Agency is not responsible for any use that may be made of the information it contains.

Author details

Vladimir Margeta[1*], Kristina Gvozdanović[1], Goran Kušec[1], Ivona Djurkin Kušec[1] and Nina Batorek-Lukač[2]

1 Faculty of Agrobiotechnical Sciences, Osijek, Croatia

2 Agricultural Institute of Slovenia, Ljubljana, Slovenia

*Address all correspondence to: vmargeta@pfos.hr

References

[1] Uremović M. Crna slavonska svinja ulazi u fazu izčezavanja. Agronomski Glasnik. 2005;**57**(4–5):311-316

[2] Karolyi D, Luković Z, Salajpal K. Crna slavonska svinja. Meso. 2010; **12**(4):222-230

[3] Hrvatska Poljoprivredna Agencija (HPA). HPA—Godišnje Izvješće za [Internet]. 2017. Available from: http://www.hpa.hr/godisnja-izvjesca/ [Accessed: 21-9-2017]

[4] Budimir K, Margeta V, Kralik G, Margeta P. Silvo pastoral keeping conditions of the black slavonian pigs. Krmiva. 2014;**55**(3):151-157

[5] Margeta V, Gvozdanović K, Margeta P, Kušec ID, Radišić Ž, Galović D, et al. Low input production system suitable for black Slavonian pig breeding. Acta Argiculturae Slovenica. 2016;**5**:122-126

[6] Margeta V, Gvozdanović K, Galović D, Grčević M, Radišić Ž. Production and carcass traits of Black Slavonian fattening pigs to higher final body weight. In: Lulić S, editor. Zbornik Sažetaka KRMIVA 2016; 1-6 June 2016; Opatija, Croatia. Zagreb, Croatia: KRMIVA d.o.o.; 2016. pp. 67-68

[7] Margeta V, Gvozdanović K, Djurkin Kušec I, Margeta P, Kušec G, Radišić Ž. The effect of the acorn in feeding on the production and slaughter traits of crna slavonska pig. In: Petrović M, editor. Proceedings of the 11th International Symposium Modern Trends in Livestock Production; 11-13 October 2017; Belgrade, Serbia. Belgrade, Serbia: Institute for Animal Husbandry; 2017. pp. 327-334. ISBN: 978-86-82431-73-2

[8] Uremović M, Uremović Z, Luković Z. Production properties of the black Slavonian pig breed. Zbornik Biotehniške Fakultete Univerze v Ljubljani, Kmetijstvo Zootehnika. 2000; **76**:131-134

[9] Uremović M, Uremović Z, Luković Z, Konjačić M. The influence of genotype and production conditions on the fertility of sows in outdoor system. Agriculturae Conspectus Scientificus. 2003;**68**:245-248

[10] Senčić DJ, Antunović Z, Andabaka Z. Reproduktivna svojstva crne slavonske svinje–Ugrožene pasmine. Poljoprivreda. 2001;**7**:39-42

[11] Luković Z, Mahnet Ž, Karolyi D, Salajpal K, Škorput D. Genetic parameters for litter size in Black Slavonian pigs with each parity treated as a different trait. In: Dovč P, Čandek-Potokar M, editors. Acta Argiculturae Slovenica, Supplement 4; 10-12 October 2013; Ljubljana, Slovenia. Ljubljana, Slovenia: Biotechnical Faculty University of Ljubljana; 2013. pp. 3-35

[12] Obad I. Čimbenici plodnosti crne slavonske svinje [thesis]. Zagreb, Croatia: University of Zagreb, Faculty of Agriculture, Department of Animal Science; 2016. p. 26

[13] Margeta V, Gvozdanović K, Margeta P, Djurkin Kušec I, Radišić Ž, Galović D, Kušec G. Low input production system suitable for Black Slavonian pig breeding // Acta argiculturae Slovenica, 2016 (2016), Suppl. 5; 122-126

[14] Skorput D, Gorjanc G, Dikić M, Luković Z. Genetic parameters for litter size in black Slavonian pigs. Spanish Journal of Agricultural Research. 2014; **12**:89-97

[15] Kralik G, Petričević A, Jovanovac S, Senčić Đ. Black slavonian pig. Stočarstvo. 1994;**48**:371-376

[16] Luković Z, Karolyi D, Klišanić V, Mahnet Ž, Gantner V, Škorput D.

Genetic parameters and trends for litter size in Black Slavonian pigs. In: De Pedro EJ, Cabezas AB, editors. Options Méditerranéennes: Série A. Séminaires Méditerranéens; n. 101; 14–16 October 2010; Córdoba, Spain. Zaragoza, Spain: CIHEAM; 2012. pp. 71-73

[17] Morić V. Estimation of heritability for litter size in population of Black Slavonian pig [thesis]. Zagreb, Croatia: Agronomski Fakultet, Sveučilište u Zagrebu; 2011

[18] Hrvatska Poljoprivredna Agencija (HPA). HPA—Godišnje Izvješće za [Internet]. 2006. Available from: http://www.hpa.hr/godisnja-izvjesca/ [Accessed: 21-9-2017]

[19] Živković I. Voluminozna krmiva u hranidbi crne slavonske svinje [thesis]. Osjek, Croatia: Josip Juraj Strossmayer University of Osijek, Faculty of Agriculture, Department for Animal Husbandary; 2016

[20] Živković I, Gvozdanović K, Galović D, Steiner Z, Margeta V. Alfalfa as a protein supplement in feeding of Black slavonian pig-fajferica. In: Vila S, Antunović Z, editors. Proceedings of the 52. hrvatski i 12. međunarodni simpozij agronoma; 12-17 February 2017; Dubrovnik, Croatia. Osijek, Croatia: Sveučilišta Josipa Jurja Strossmayera u Osijeku; 2017. pp. 589-593

[21] Poljak A. Utjecaj dobi prvopraskinja na reproduktivna svojstva crne slavonske svinje [thesis]. Križevci, Croatia: Križevci College of Agriculture; 2017

[22] Kabalin AE, Starčević K, Menčik S, Maurić M, Sušić V, Štoković I. Analysis of ESR and RBP polymorphisms in black Slavonian sows: Preliminary results. In: Dovč P, Čandek-Potokar M, editors. Acta Argicul Slov Supplement 4; 10-12 October 2013; Ljubljana, Slovenia. Ljubljana, Slovenia: Biotechnical Faculty, University of Ljubljana; 2013. pp. 45-48

[23] Menčik S, Sabbioni A, Ostović M, Mahnet Ž, Beretti V, Superchi P, et al. Effect of seasonality on litter size traits in black slavonian and "Nero di Parma" pigs. Stočarstvo. 2016;**69**:3-10

[24] Senčić Đ, Bukvić Ž, Antunović Z, Šperanda M. Slaughter quality of black Slavonian pig–endangered breed and its cross-breeds with Swedish landrace while keeping them outdoor. Poljoprivreda. 2005;**11**:43-49

[25] Karolyi D, Salajpal K, Sinjeri Ž, Kovačić D, Jurić I, Đikić M. Meat quality, blood stress indicators and trimmed cut yield comparison of black Slavonian pig with modern pigs in the production of Slavonian Kulen. Acta Agriculturae Slovenica. 2004;**1**:67-72

[26] Karolyi D, Salajpal K, Sinjeri Ž, Kovačić D, Jurić I, Đikić M. Kvaliteta mesa i iskorištenja trupa crne slavonske i modernih svinja u proizvodnji kulena. Meso. 2006;**8**:29-33

[27] Butko D, Senčić Đ, Antunović Z, Šperanda M, Steiner Z. Pork carcass composition and the meat quality of the black Slavonian pig–the endangered breeds in the indoor and outdoor keeping system. Poljoprivreda. 2007;**13**: 167-171

[28] Senčić Đ, Butko D, Antunović Z. Evaluacija crne slavonske svinje u odnosu na sustav držanja i križanje. Stočarstvo. 2008;**62**:69-73

[29] Salajpal K, Karolyi D, Kantura V, Nejedli S, Đikić M. Muscle fiber characteristics of Black Slavonian pig–autochthonous Croatian breed. In: Nanni Costa L, Zambonelli P, Russo V, editors. Proceedings of 6th International Symposium on the Mediterranean Pig; 11-13 October 2007; Capo d'Orlando, Italy. Bologna, Italy: AlmaDL; 2008. pp. 293-293

[30] Salajpal K, Karolyi D, Đikić M, Kantura V, Kiš G, Sinjeri Ž. Influence of acorn intake on blood lipid profile and longisimus muscle characteristics of Black Slavonian pig. In: Dovč P, Petrič N, Žgur S, Kompan D, Siard N, editors. Acta agriculturae Slovenica, Supplement 2; 17-19 September 2008; Strunjan, Slovenia. Ljubljana, Slovenija: Biotechnical Faculty, University of Ljubljana; 2008. pp. 99-105

[31] Marušić L. Proizvodna svojstva svinja crne slavonske pasmine u otvorenom sustavu držanja [thesis]. Zagreb, Croatia: University of Zagreb, Faculty of Agriculture; 2010. p. 31

[32] Baković M, Gvozdanović K, Galović D, Radišić Ž, Margeta V. Klaonička svojstva tovljenika crne slavonske svinje iz ekstenzivnog uzgoja. Krmiva. 2016; **58**:3-8

[33] Kralik G, Margeta V, Kralik I, Budimir K. Specifičnosti svinjegojske proizvodnje u Republici Hrvatskoj—Stanje i perspektive. Krmiva. 2012;**54**: 59-70

[34] Senčić Đ, Butko D, Antunović Z, Novoselec J. Utjecaj tjelesne mase na kvalitetu polovica i mesa crne slavonske svinje. Meso. 2008;**10**:274-278

[35] Senčić Đ, Samac D, Antunović Z, Novoselec J, Klarić I. Utjecaj razine sirovih proteina u krmnim smjesama na kvalitetu polovica i mesa crnih slavonski svinja. Meso. 2010;**12**:28-33

[36] Senčić Đ, Samac D, Antunović Z, Novoselec J, Klarić I. Influence of crude protein level in forage mixtures on pig meat and carcass quality. Macedonian Journal of Animal Science. 2011;**1**:89-93

[37] Senčić Đ, Samac D, Steiner Z. Influence of nutrition of black Slavonian pigs on the quality of ham and cured ham. Macedonian Journal of Animal Science. 2013;**3**:57-61

[38] Margeta V, Gvozdanović K, Galović D, Grčević M, Margeta P, Radišić Ž. Production and carcass traits of Black Slavonian fattening pigs to higher final body weight. In: Lulić S, editor. Zbornik Sažetaka KRMIVA; 1-3 June 2016; Opatija, Croatia. Zagreb, Croatia: 2016. pp. 67-68

[39] Senčić Đ, Samac D, Antunović Z. Utjecaj proizvodnog sustava na fi zikalno-kemijska i senzorska svojstva mesa crnih slavonskih svinja. Meso. 2011;**13**:32-34