Chapter

Krškopoljski prašič (Krškopolje Pig)

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Abstract

This chapter presents the history and the current state-of-the-art in the only Slovenian autochthonous pig breed - Krškopolje pig. A review of literature regarding productive traits was carried out. The reproductive performance includes sow age at first parturition and at culling, litters per sow per year, number of live born and percentage of stillborn piglets per litter, piglet birth and weaning weight, mortality at weaning, duration of lactation and length of farrowing interval. Growth performance was evaluated as average daily gain in lactation, post-weaning, and early, mid, or late fattening. Daily feed intake in different stages was also assessed. Review also addresses age and weight at slaughter, and carcass traits: hot carcass weight, carcass yield, lean meat content, backfat and muscle thickness, and loin eye area. Meat quality traits considered were Longissimus muscle pH, objective colour parameters and intra muscular fat content. Additionally, fatty acid composition of intramuscular fat and backfat tissue was considered. Although studies on Krškopolje pig are scarce and the results on productive traits should be interpreted with precaution, due to different production systems and feeding strategies used in considered studies, the current review gives the first overview on this local pig breed in its current phenotype.

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

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

Slovenia has only one preserved indigenous local pig breed, the Krškopolje pig (in Slovenian, Krškopoljski prašič). The oldest known record about Krškopolje pig dates back to the year 1899 when Rohrman described a widespread pig production in Dolenjska region, especially in the area of Krško polje (Krško is the name of the town and "polje" means field in Slovenian). In the old literature, Krškopolje pig was also named the black-belted, belted or striped pig. The breed became endangered due to official campaign against Krškopolje pig in the 1960s; consequently, the last official records about the breed and fertility data were reported in 1972 before its revival in the early 1990s of the twentieth century when in situ gene bank was implemented [1]. In that time around 40 farms were still raising Krškopolje pigs [2]. Promotion and support for organic farming along with the subsidies for the use of Krškopolje pig

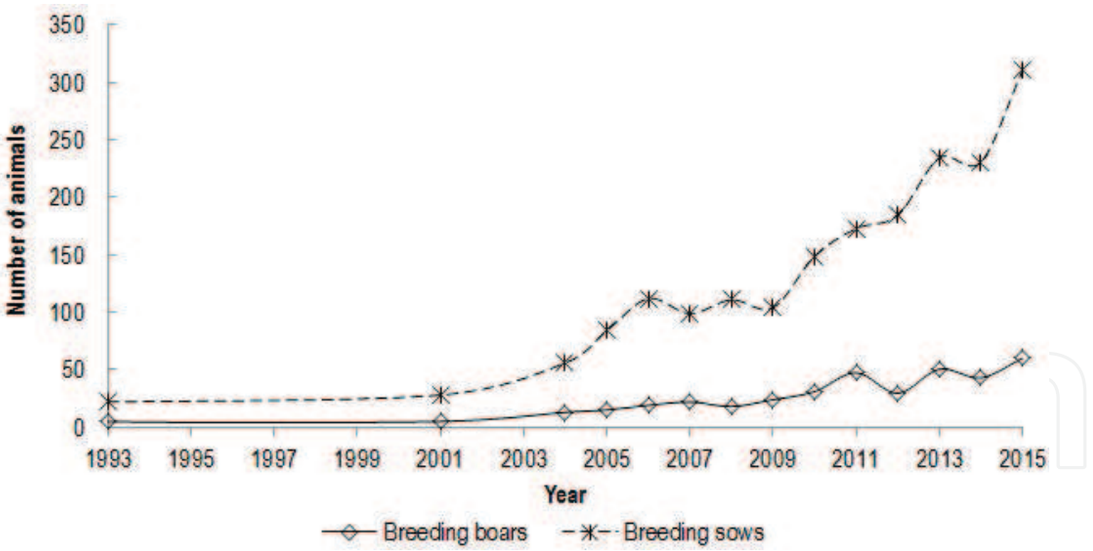

Figure 1.
Census of the Krškopolje pig breed, presenting a number of sows and boars per year, starting with the year of heard book establishment.

increased the interest for the breed. After the year 2003, when individual marking of all newborn piglets was introduced, the interest for breeding the Krškopolje pigs has increased. Census of the Krškopolje pig breed is presented in **Figure 1**. Presently, there are 130 registered farms of the Krškopolje pigs with about 311 breeding sows and 60 boars in the latest available status (August 2015). However, the breeders have on average only one to two sows.

2. Exterior phenotypic characteristics

The Krškopolje pig breed morphology information is summarised in **Table 1**. It is a middle to large sized breed of black coat colour and a characteristic continuous white belt across the shoulders and forelegs (**Figures 2** and **3**). The head is medium sized, with looped ears of medium length. The face should be slightly dished and the nose top white. The body is wide and not too deep, the back is long, wide and straight, the shoulders are strong and medium in width, and the hams are broad,

Measurement (average)	Adult male	Adult female
Body weight (kg)	280	230
Body length[1] (cm)	152	140
Head length (cm)	63	30
Tail length (cm)	45	41
Ear length	Large	Medium
Chest girth (cm)	—	140
Height at withers (cm)	87	83
Number of teat	—	14

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

Table 1.
Summary of morphology information on the Krškopolje pig breed.

Figure 2.
Krškopolje sow with piglets.

Figure 3.
Krškopolje boar.

full and long. The hair is strong, straight and dark over the pigmented parts of the body. Their temperament is calm.

3. Geographical location and production system

The origin of the Krškopolje pig is geographically located in the south-east part of the Dolenjska region, the area of Krško-Brežiško field and the foothills of Gorjanci hills. However, nowadays farms with the Krškopolje pigs are distributed throughout Slovenia (**Figure 4**). The breed is adapted to poor rearing conditions, is robust and efficiently uses the forage; thus, it can be kept outdoors. Traditionally, the Krškopolje pigs were kept in a mixed production system—with indoor housing and access to outdoor area. Indoor housing was usually in pens with the

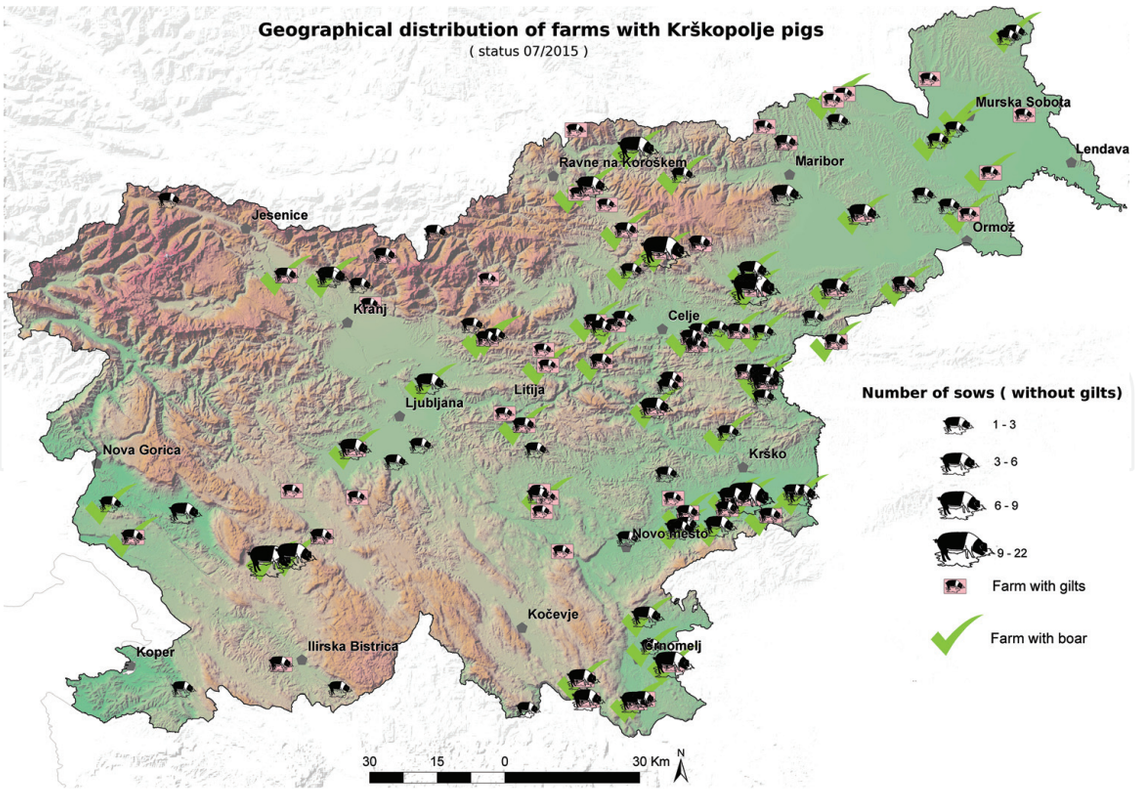

Figure 4.
Geographical distribution of Krškopolje pig breeders with size of their herds, i.e. number of sows.

full floor and straw bedding or deep litter. Water and feed were provided twice per day (morning and late afternoon) in wooden troughs. Pigs were fed with locally available seasonal ingredients that were usually pre-cooked in large kettles. The feed mixture was composed of seasonal vegetable (e.g. carrots, turnips, beets, cabbage and potatoes), cereals (barley, oats, wheat, triticale, buckwheat and millet) and residual food from the household. Sometimes, skimmed milk or whey was added. Additionally, fresh grass or clover in spring and summer and grass or alfalfa hay in winter was provided through the day. Nowadays, animals of the Krškopolje pig breed are being reared in various production systems: from more intensive indoor system with conventional feed mixture to fully outdoor system where pigs are fed with various crops and kept on pasture. They are provided a shelter in case of unfavourable weather conditions and are moved indoor only in strong winter.

4. Organisations for breeding, monitoring and conservation

The Krškopolje pig is listed among the endangered Slovenian breeds of farm animals. The breed is included in the breeding programme for pigs SloHibrid, which is run by the Chamber for Agriculture and Forestry of Slovenia. However, the Association of breeders of Krškopolje pig breed[1] has prepared their own breeding programme, which has recently been approved by the Ministry of Agriculture, Forestry and Food.

[1] Društvo rejcev Krškopoljskih prašičev = Association of breeders of Krškopolje pig; Cesta prvih borcev 41, 8250 Brežice, Slovenia; web address: http://www.krskopoljski-prasic.si/; e-mail address: info@krskopoljski-prasic.si

5. Productive performance

5.1 Reproductive traits

The basic data obtained on reproductive traits in this review are presented in **Table 2**. The age of sows at the first parturition is around 14 months (12–16 months [3–6, 9, 10, 12])denoting the age at which sows reach a target weight of 100 kg when they are usually mated for the first time is to some extent later than in intensively kept modern breeds. The breed has moderately good fertility. On average sows of the Krškopolje pig breed have 1.8 litters per year [1, 3, 5–10] with between 8.1 and 10.5 piglets [1–6, 8–10, 12] of approximately 1.2 kg live body weight [10]. Stillborn percentage of piglets is very variable and ranges between 5.7 and 21.9% [1–3, 5, 6, 8, 9, 12], in most studies being slightly higher than 7% desired in a normal indoor herd unaffected by specific disease [13]. However, regarding the fact that piglet mortality in loose farrowing systems commonly ranges from 20–33% [14, 15], which is about twofold greater than that normally occurring in confinement farrowing crates [16], mortality at weaning in the considered studies of Krškopolje is satisfactory (8.1 to 26.7% [1–3, 5, 6, 8–10, 12]). Duration of lactation is prolonged in comparison to modern intensive systems (to approximately 44 days [1, 3, 6–8, 11, 12]), which leads to a longer farrowing interval (between 187 and 240 days [1, 3, 6–10, 12]) and consequently a lower number of piglets produced per sow per year (16.9; data not shown). On average sows have 5.6 litters in their lifetime (data not shown [1, 7]), which corresponds to results obtained in modern breeds [17].

5.2 Growth performance

The basic data on growth performance obtained in this review are presented in **Tables 3** and **4**. Due to big differences between studies concerning 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. Sometimes, the source provided only the overall growth rate for the whole fattening stage (defined as overall) or even from birth to slaughter (defined as birth–slaughter, which is often calculated from the data given on live weight and age of pigs). It should also be noted that a big part of the collected studies simulated practical conditions of the production systems used in practice and that only a smaller part of the studies exhibit the breed potential for growth. In the considered studies, daily gain in the early growing stage, which corresponds to lactation period (195–355 g/day [8, 18, 19, 25, 26]), is in the range of values described for leaner breeds. However, it should be taken into account that the lactation period (approximately 44 days; **Table 3**) is considerably greater than in sows of conventional breeds (21–28 days). Average daily gain in the growing stage (between 207 and 385 g/day [8, 18, 19, 25, 26]) is lower than in modern breeds, which denotes lower intensity of rearing. Also, the early, middle, late and overall fattening stages are generally characterised by slower growth and big heterogeneity (355–934, 352–968, 533–1085 and 352–951 g/day in early, middle, late and overall growing stage, respectively), related to the fact that this review comprises studies where different systems and feeding levels were practised. 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 Krškopolje pigs in ad libitum conditions of feeding (≈951 g/day in overall fattening stage).

Reference	Sow age at the first parturition (mth)	Litters per sow per year	No. of piglets alive per litter	Piglet live weight (kg)	Stillborn per litter (%)	Mortality at weaning (%)	Piglet weaning weight (kg)	Duration of lactation (d)	Farrowing interval (d)	Sow age at culling[1] (mth)
[1]	—	1.9	9.1	—	9.7	19.5	—	41	193	39.0
[2]	—	—	8.9	—	8.8	8.1	—	—	—	—
	—	—	8.1	—	21.9	26.7	—	—	—	—
[3]	15.3	1.8	9.4	—	8.8	19.9	—	50	200	—
[4]	14.2	—	9.6	—	—	—	—	—	—	—
[5]	16.2	1.4	9.3	—	8.3	17.5	—	—	—	—
[6]	13.9	2.0	9.3	—	9.6	19.5	—	39	187	—
[7]	—	1.8	—	—	—	—	—	45	205	34.2
[8]	—	1.5	9.1	—	5.7	17.6	—	53	240	—
[9]	12.0	1.8	10.5	—	11.5	17.0	—	—	207	—
[10]	16.0	1.8	9.0	1.2	—	22.2	—	—	203	—
[11]	—	—	—	—	—	—	8.6	38	—	—
[12]	15.5	—	9.3	—	8.5	20.8	—	50	200	—

No. = number, mth = month, d = days.
[1]Calculated as number of farrowing in lifetime divided with litters per sow per year and multiplied with 12.

Table 2.
Summary of collected literature data on reproduction traits in the Krškopolje pig breed.

Reference	Feeding	No. of animals	ADG lactation[1]	ADG growing[2]	ADG fattening[3]				ADG birth–slaughter
					Early	Middle	Late	Overall	
[2]	—	27	—	—	—	—	—	625	—
[8, 18, 19]	Semi	36	195	385	784	826	629	734	526
[11]	Semi	6	—	—	648	475	580	562	—
	Semi	6	—	—	455	475	—	465	—
[20]	—	20	—	—	463	—	629	558	—
[21–23]	Ad Lib	10	—	—	934	968	1085	951	637
[24]	Semi	17	—	—	—	—	—	—	497
[25, 26]	Rest	10	225	225	—	352	—	352	—
	Semi	40	355	355	355	—	533	355	463
	Rest	23	—	207	—	585	—	585	377

No. = number, ADG = average daily gain in g, Ad Lib = ad libitum feeding regime, Semi = semi ad libitum *feeding regime, Rest = restrictive feeding regime.*
[1]ADG in a period of lactation regardless of how long it was.
[2]ADG in a growing period estimated from weaning to approximately 30 kg live body weight.
[3]ADG in a period of fattening is reported for 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. Sometimes, the source provided only the overall growth rate for the whole studied period (in that case defined as overall).

Table 3.
Summary of collected literature data on average daily gain (in g) in the Krškopolje pig breed.

Reference	Feeding	ME content of feed (MJ/kg)	CP content of feed (%)	No. of animals	ADFI growing[1]	ADFI fattening[2]			
						Early	Middle	Late	Overall
[2]	—	—	—	27	—	2.1	2.1	—	—
[8, 18, 19]	Semi	12.7	14.8	36	1.07	2.53	3.36	3.19	2.99

No. = number, ADFI = average daily feed intake in kg/day, Semi = semi ad libitum *feeding regime, ME = metabolisable energy, CP = crude protein.*
[1]ADFI in a growing period estimated from weaning to approximately 30 kg live body weight.
[2]ADFI in a period of fattening is reported for 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. Sometimes, the source provided only the overall daily feed intake for the whole studied period (in that case defined as overall).

Table 4.
Summary of collected literature data on average daily feed intake (in kg/day) in the Krškopolje pig breed.

In considered studies, the information on feed intake and feed nutritional value were rarely provided, which limits the evaluation of growth potential, because growth is directly related to both energy and nutrient supply. Average daily feed intake increased from 1.1 kg/day in growing stage to max 3.2 kg/day in the late fattening stage when *semi ad libitum* feeding regime was applied [8, 18, 19].

5.3 Body composition and carcass traits

The basic data obtained in this review with some of the most commonly encountered carcass traits that could be compared are presented in **Table 5**. In considered studies, pigs were slaughtered at approximately 276 days of age [11, 20, 24, 26, 27, 31], between 88 and 146 kg, i.e. an average 118 kg live weight [2, 11, 20–24, 26–29, 31]. Dressing yield was around 77% [2, 20–23, 26–29, 31] and

Reference	No. of animals	Final age (d)	Final BW (kg)	Hot CW (kg)	Dressing yield (%)	Lean meat content (%)	Backfat thickness (mm)			M[1] (mm)	Loin eye area (cm^2)
							S[2]	At withers	At last rib		
[2]	27	—	90	70	77.1	—	—	—	—	—	26
[11]	6	228	120	—	—	—	—	—	40	—	—
	6	220	88	—	—	—	—	—	22	—	—
[20]	20	312	146	—	71.6 [3]	—	—	—	—	—	—
[21–23]	10	—	139	111	79.3	42.2	44	—	—	49	36
[24]	17	245	123	98	—	46.2	—	—	29	—	42
[26, 27]	10	347	—	96	—	47.8	33	45	40	61	—
	40	303	140	109	77.9	39.7	40	67	49	67	—
	23	328	125	95	75.9	44.2	34	48	41	69	—
[28]	9	—	90	71	78.4	—	—	—	35	—	23
[29]	4	—	118	94	79.6	—	—	—	33	—	—
[30]	10	—	—	93	—	47.8	33	—	—	61	—
[31]	24	228	123	98	80.4	42.9	36	53	—	—	36

No. = number, BW = body weight, CW = carcass weight.
[1]M muscle thickness measured according to ZP method (at the cranial edge of gluteus medius muscle (mm)).
[2]S backfat thickness measured according to ZP method (above gluteus medius muscle (mm)).
[3]The skin, feed and head are removed.

Table 5.
Summary of collected literature data on body composition and carcass traits in the Krškopolje pig breed.

lean meat content around 44% (39.7 to 47.8%; SEUROP classification or dissection [21–24, 26–29, 31]). The backfat thickness values measured on the withers spanned from 45 to 67 mm [26, 27, 31], at the level of the last rib from 22 to 49 mm [11, 26–29] and at the level of gluteus medius muscle from 33 to 44 mm [21–23, 26, 27, 30, 31]. Muscularity measured as loin eye area varied from 23 to 42 cm^2 [2, 21–24, 28, 31] and muscle thickness measured at the cranial edge of gluteus medius muscle from 49 to 69 mm [21–23, 26, 27, 30], which indicates lower muscular development in the Krškopolje pig compared to modern breeds. This variation in backfat and muscle thickness is also a consequence of the wide range of the final live weight (88 to 146 kg) of pigs and different feeding regimes applied in considered studies.

5.4 Meat quality

The basic data obtained in this review with some of the most commonly encountered meat and fat quality traits measured in longissimus muscle that could be compared are presented in **Table 6**. In the few studies reporting meat quality of Krškopolje pigs, pH values measured in longissimus muscle at 45 min and 24 h post-mortem were around 6.08 [24, 30–40] and 5.47 [11, 21–24, 30–40], respectively. Relatively low average value of pH 45 in the considered studies could be an indicator of a higher presence of an RYR1 mutation in the Krškopolje pig breed [24, 41]. pH 24 values in the considered studies are somewhat higher than in modern breeds, which is indicative of lower glycogen stores before slaughter. This corroborates with higher intramuscular fat content (2.0–4.3% [11, 24, 30–40]), both indicative of more oxidative muscle metabolism. In agreement with this, colour measurements

Reference	No. of animals	pH 45	pH 24	CIE[1]			IMF (%)	FA[2] composition of IMF (%)				FA[2] composition of BFT (%)			
				L*	a*	b*		SFA	MUFA	PUFA	n6/n3	SFA	MUFA	PUFA	n6/n3
[11]	6	—	5.46	50	6.6	0.9	2.8	—	—	—	—	—	—	—	—
	6	—	5.43	48	8.5	1.0	3.1	—	—	—	—	—	—	—	—
[21–23]	10	—	5.50	56	10.9	7.3	—	—	—	—	—	—	—	—	—
[24, 32]	17	5.84	5.59	54	9.7	4.9	3.0	—	—	—	—	—	—	—	—
[28]	8	—	—	—	—	—	2.7	—	—	—	—	—	—	—	—
[30]	—	—	—	—	—	—	—	33.8	48.6	17.6	14.5	—	—	—	—
[30, 33–40]	10	—	5.49	48	9.5	2.4	2.0	33.8	48.6	17.6	14.3	36.1	50.8	12.7	12.1
	40	6.00	5.42	.	10.7	—	4.3	37.0	55.1	7.9	13.5	40.5	50.6	8.9	18.8
	23	6.00	5.28	.	9.3	—	2.1	34.4	42.4	23.3	10.3	36.7	45.3	18.0	8.2
[31]	24	6.49	5.59	52	7.4	1.6	3.0	41.0	47.5	11.6	15.7	42.2	43.6	14.7	12.9

No. = number, pH 45 = pH measured approximately 45 minutes post-mortem*, pH 24 = pH measured approximately 24 hours* post-mortem*, FA = fatty acid, IMF = intramuscular fat, BFT = backfat tissue, SFA = saturated fatty acids, MUFA = monounsaturated fatty acids, PUFA = polyunsaturated fatty acids, n6/n3 = the proportion between n-6 and n-3 polyunsaturated fatty acids.*

[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.*

[2]For fatty acid composition, only pigs on control diet were considered. Control diets differed among studies, to see diet composition address to the corresponding source.

Table 6.
Summary of collected literature data on meat quality in the Krškopolje pig breed.

(Minolta L value; L* = 48 to 52 [11, 21–24, 30–40]) confirm a bit more intensive colour of meat. In the considered studies, SFA, MUFA and PUFA contents were approximately 36, 48 and 16% for intramuscular fat in longissimus muscle [30, 31, 33–40] and approximately 39, 48 and 14% for backfat tissue [30, 31, 33–40]. Due to big differences between studies concerning the feeding regime, feed composition, final body weight and fatness, which are all important factors influencing the fatty acid composition of meat, it is difficult to interpret the results on the fatty acid composition. Nevertheless, it can be concluded that the results obtained from the considered studies indicate a higher proportion of MUFA and SFA in Krškopolje pigs and lower PUFA content in comparison to the modern meaty type of pigs. This can be attributed to higher synthesis of MUFA and SFA [42], caused by higher fat deposition in this breed of pigs, as shown by the results of body composition (**Table 5**).

6. Use of breed and main products

The Krškopolje pig is intended for production of high-quality meat and fat. Pigs are raised in poorer conditions, with less concentrated feeds and with additional fibre feed. The breed is prone to fat deposition, but meat contains relatively high content of intramuscular fat, which makes it tastier. It is suitable for roasted pork or preparation of traditional dried products (e.g. salami, sausages, dry cured hams and pancetta). In the year 2017, an association of breeders of the Krškopolje pig registered a trademark "Meat products from Krškopolje pig" (**Figure 5**), which can be used by registered breeders within the Association of breeders of Krškopolje pig breed for products made exclusively from meat and fat of the Krškopolje pig.

Figure 5.
Logo for trademark "Meat products from Krškopolje pig".

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