

KRŠKOPOLJE PIG IN TREASURE PROJECT: FROM REARING TO PRODUCT

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Abstract: Krškopolje pig, a Slovenian autochthonous breed, is poorly studied and exploited, as is the case in many autochthonous (local) pig breeds. More knowledge about various aspects of breed as characterisation, performances, product quality and socio-economic relevance is needed for the development of sustainable pork value chains. To answer these challenges, the studies are conducted within H2020 project TREASURE spanning from rearing to product evaluation. In this work, an overview of the first partial and preliminary results are presented for Krškopolje pig which concern the evaluation of growth performance in different rearing systems, effect of the incidence of *RYRI* gene mutation and sensory quality and consumer acceptability of new traditional product (dry-cured sausage – salami type) from Krškopolje pigs.

Keywords: autochthonous breed, Krškopolje pig; growth performance, *RYRI* mutation, sausages, consumer test

Introduction

Slovenia has only one preserved autochthonous (local) pig breed, the Krškopolje pig which has a black coat colour with a white belt across shoulders and forelegs. In the seventies of the last century, the breed was gradually abandoned and became endangered. In the early nineties of the 20th century *in situ* gene bank and herd book were created. An important milestone was also the year 2003 when individual marking of all newborn piglets was introduced (Kastelic and Čandek-Potokar, 2013). The interest for Krškopolje breed has been revived in the last years, esp. on organic farms and on family farms with direct product sales. The

public aid for the conservation of this breed contributes to its wider use. Presently, Krškopolje breed is not at risk of extinction, however the breed is far from being safe. In order to develop a sustainable use of Krškopolje pig and thus its preservation, it would be necessary to develop economically sustainable exploitation through valorisation of its products. As is the case for other local pig breeds, Krškopolje pig is reared in very diverse conditions adapted to the specific local environment. Typically, farmers are rearing these pigs on a small scale basis in rather extensive conditions, often using a combination of indoor and outdoor system. The breed is reputed for excellent meat quality and used for traditional pork products appreciated by consumers. However in terms of the scientific substantiation, there is practically no information about nutritional requirements of this breed, the performances, productive traits and quality of products are practically untapped and studies dealing with this breed are lacking. Studies are thus needed to acquire more knowledge as the basis and essential for the development of sustainable pork value chains. In light of this, experiments and studies on Krškopolje breed are conducted within H2020 project TREASURE from rearing to product development and an overview of the first partial or preliminary results are presented in this paper.

Materials and Methods

Growth performance of piglets in lactation phase

Piglets (n=156; 68 females and 88 castrated males) from 7 organic and 11 conventional farms were weighed at weaning (4-6 weeks). Daily gains were calculated based on weaning weight and average birth weight (1.2 kg). Details of the study (experimental design and statistical analysis) are described in *Tomažin et al. (2016)*.

Growth performance in the growing phase

Three piglets (castrates) per litter were selected from 12 farms/litters at the average age of 55 days and average weight of 14 kg, and assigned within litter to three groups. One group (two pens of 6 pigs) received organic (ECO) feed mixture (12.8 MJ ME/kg, 17.8% crude protein (CP), 0.8% lysine and 11.9 MJ ME/kg, 15% CP, 0.6% for growing and fattening diets, respectively) while the other group (four pens of 6 pigs) received conventional (CON) feed mixture (13.6 MJ/kg, 16.8% crude protein, 1.0 lysine and 11.6 MJ ME, 15.3% CP, 0.9% lysine for growing and fattening diets, respectively). The pigs were given an *ad libitum* access to feed and were weighed every 2 weeks until the average age of 155 days and daily gains were calculated.

Fattening trial in conventional and organic system

Pigs were assigned within litter to three treatment groups; ECO (n=12), CON (n=12) and CON+L (n=12). Two barley based diets were prepared. For ECO pigs (n=12), the diet (12.4 MJ ME/kg, 12.9% CP, 0.7 % Lys) was based on organically produced crops whereas for CON and CON+L pigs, the diet (13.2 MJ ME/kg, 13.6% CP, 1.2 % Lys) was based on the same ingredients but from conventional crop production. ECO pigs were supplemented with lucerne hay, CON+L pigs were supplemented with pelleted lucerne and received 10% less feed mixture than CON and ECO. Pigs in CON and CON+L were housed indoors, whereas ECO pigs were reared respecting the rules for organic production. Details of the study design are described in *Batorek et al. (2016)*.

Fattening performance of Krškopolje pigs in extensive and intensive system

The growing and fattening of pigs was conducted on two farms. Twelve pigs from twelve farms/litters were delivered to both farms at similar age (85.9±2.5 days) and live weight (26.3±2.1 kg). On the extensive (EXT) farm, the pigs (n=6) were housed in a pen (15 m²) with access to outdoor area (50 m²) and fed cooked potatoes and root crops supplemented with mixture of cereals, whereas on the intensive farm, the pigs (n=6) were housed indoors (in a pen of 7.5 m²) and fed complete feed mixture. Pigs were monitored for 138 days and were weighed 4 times (at 86, 129, 195, 224 days) with 4 growth stages (25-45, 45-75, 75-90 and 90-120 kg) considered (for more information see *Tomažin et al., 2017a*).

Effect of the RYR1 mutation in Krškopolje pigs

Unrelated Krškopolje castrates reared in equivalent conditions (at the same farm and fed complete feed mixtures adapted to the stage of growth) were genotyped for recessive mutation c. C1843T (p. Arg615Cys) at *RYR1* locus (recessive allele further denoted as “n”; “N” stands for wild type allele). Carcass traits and meat quality were compared between N/n (n=15) and N/N pigs (n=20) (more information in *Tomažin et al., 2017b*).

The quality of salami from Krškopolje pigs as compared to standard product

The effect of raw material (meat and back fat) from Krškopolje pigs on quality parameters of non-smoked dry-cured sausage (salami) was assessed. Salami was produced by the same producer with the same processing procedure (additives, temperature and relative humidity regime, dry-curing and ripening duration) using either standard raw material (meat, subcutaneous back fat in proportion 80:20) or using meat and subcutaneous back fat (in proportion 80:20) from Krškopolje pigs.

Consumer acceptance for salami from Krškopolje pigs as compared to standard product

Consumer sensory test were performed in order to determine the consumer acceptability and preferences for non-smoked dry-cured sausage (salami) made from Krškopolje pig as compared to standard product (salami made of conventional modern pig meat). For that purpose products (salami) were made using the same processing method but different raw material (meat and fat of Krškopolje vs. meat and fat of standard pig). Following the Expectation Disconfirmation Theory (EDT) (*Olson and Dover, 1979; Oliver 1997*), the sensory test included three phases, a blind sensory test with no information; an evaluation of the expected liking based on product description; a sensory test with complete information on the samples. The sensory evaluation was carried out in controlled environment with different sessions of 15 consumers by session. Participants evaluated the overall acceptability using a nine-point category scale from 1 'dislike extremely'; to 9 'like extremely'.

Results and Discussion

Growth rate of piglets in the lactation

Weight at weaning and growth rates of Krškopolje piglets raised on organic farms were approximately 20% lower than of piglets raised on conventional ones, however, the differences were not significant when taking into account the random effect of farm (Figure 1). Such results are expected in Slovenian pig farming conditions as Krškopolje pigs are most often reared on unspecialised, small extensive farms, there are often no big differences between conventionally and organically raised pigs, explaining the small differences between growth rates in lactation period between the two farming systems. The lactation periods practiced are generally longer (4-6 weeks; 38 days in average in the present study) and in such system piglets need to be supplemented with complete feed mixtures to grow well. Diets in organic pig production are often deficient in essential amino acids due to the legislation on organic farming (*Council Regulation (EC) No 834/2007*) which does not allow the use of synthetic amino acids, genetically modified organisms and feed materials processed with the aid of chemically synthesised solvents in organic diets (the latter two are particularly referring to soybean meal, which is one of the main protein sources used in conventional feed for pigs).

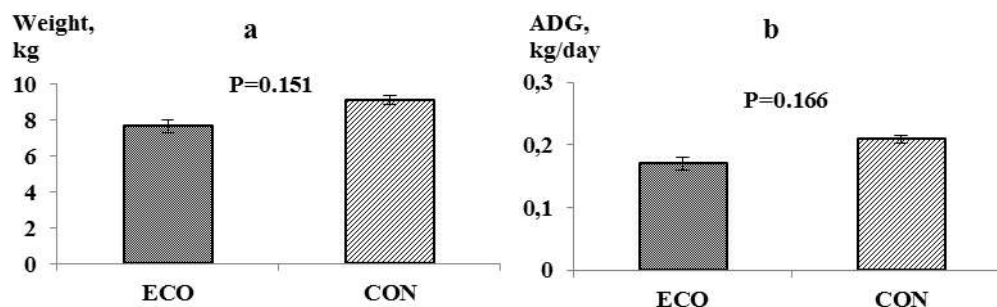


Figure 1: Weaning weight (a) and average daily gain in lactation (b) of conventionally and organically raised Krškopolje piglets

Growth performance in the growing phase (from weaning until 70 kg)

There was no major difference in weight of pigs (Figure 2a) at the beginning of the study whereas after 100 days of fattening, the pigs receiving CON diet were slightly heavier (their growth rate being 10% greater) but the difference was not significant ($P > 0.05$). Daily gain steadily increased with growth, except in a period between 83 and 97 days which could be due to high ambient temperatures (Figure 2b). Average daily gain of pigs in the period from 55 to 155 days was slightly (but not significantly) lower in ECO than CON pigs. These results suggest that no major differences in growth rates of Krškopolje pigs fed organic or conventional diet are to be expected in the case of similar nutritional value of the diet and similar rearing conditions (as was the case in the present study).

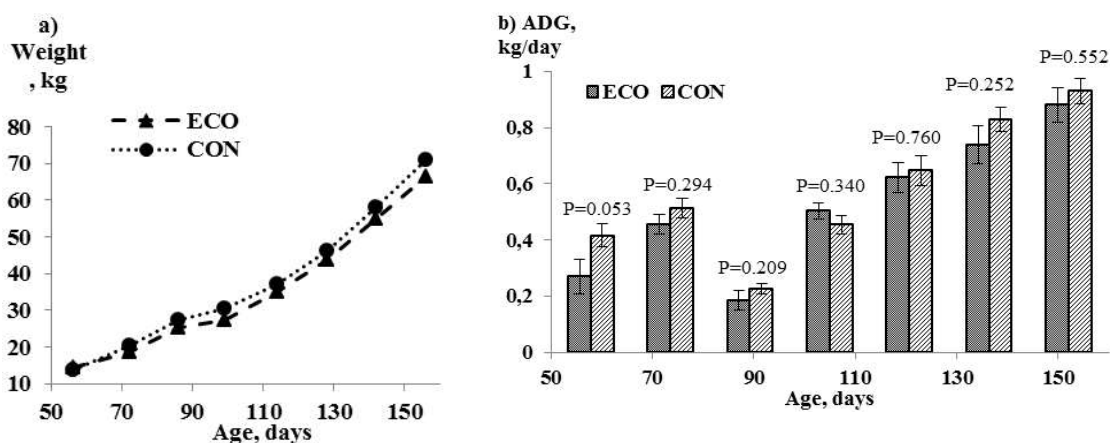


Figure 2: Weight (a) and average daily gain (ADG) (b) of pigs fed conventional (CON) or organic (ECO) feed mixtures

Fattening trial under conventional and organic system

At the beginning of the experiment there were no differences between experimental groups of pigs in body weight ($P=0.325$, Figure 3), but pigs in group ECO had thinner back fat than pigs in group CON ($P=0.019$, Figure 3). After 73 days of fattening, no differences among groups in body weight or backfat thickness (Figure 3) were observed. ECO pigs had 13% higher daily gain than pigs in group CON. This could be ascribed to high consumption of lucerne hay and possibly less feed dissipation. Pigs in group CON+L did not compensate slight dietary restriction with consumption of lucerne pellets, consequently leading to lower daily gains (11%) compared to CON pigs. No differences in backfat thickness (Figure 3) at the end of the trial and carcass traits (Figure 4) between treatment groups were noted. There were also no differences in carcass traits between the experimental groups.

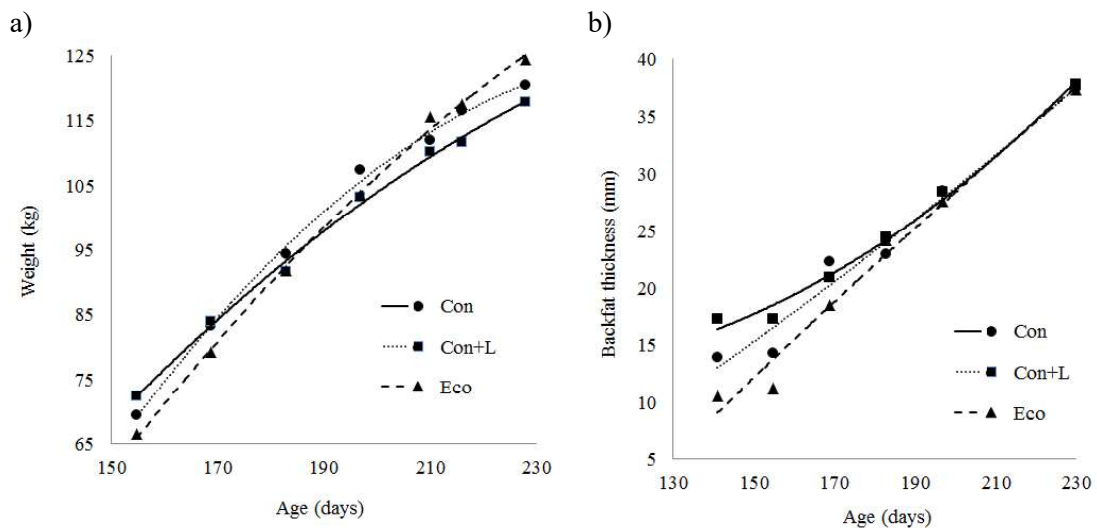


Figure 3: Gain of body weight (a) and backfat (b) in Krškoplje pigs during the experiment

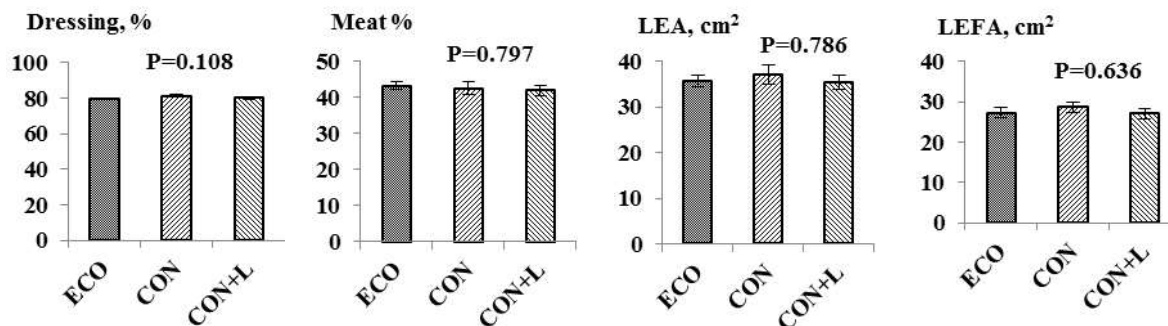


Figure 4: Dressing, meat %, loin eye area (LEA) and loin eye fat area (LEFA) of experimental Krškopolje pigs

Performance of Krškopolje pigs in extensive and intensive system

Pigs fed complete feed mixture achieved in total 49% higher daily gain and were heavier at slaughter than pigs fed traditional meal with root crops and cereals (88 vs. 120 kg, $P=0.000$). In the first observational period (25-45 kg) similar daily gain was observed for both groups, whereas pigs fed traditional meal with root crops and cereals grew slower than pigs fed complete feed mixture in the periods from 45 to 90 kg. In the last period (90-120 kg) only the pigs fed complete feed mixture were monitored, and they exhibited lower growth rate than in the previous two periods (Figure 5a). Slower growth of pigs fed traditional meal with root crops and cereals can be explained with lysine deficiency of their meal (data not shown; details about nutritional value of both diets are described in *Tomažin et al., 2017a*) As a result, owing to a greater live weight (BW) at slaughter, pigs fed complete feed mixture had thicker backfat than pigs fed traditional meal with root crops and cereals, however at equal BW (88 kg), no differences were observed. With regard to meat quality the results are indicative of more oxidative muscle metabolism of slower growing pigs fed a meal deficient in lysine (they exhibited lower CIE L* and higher CIE a* colour parameters of LD (i.e. darker, redder LD colour).

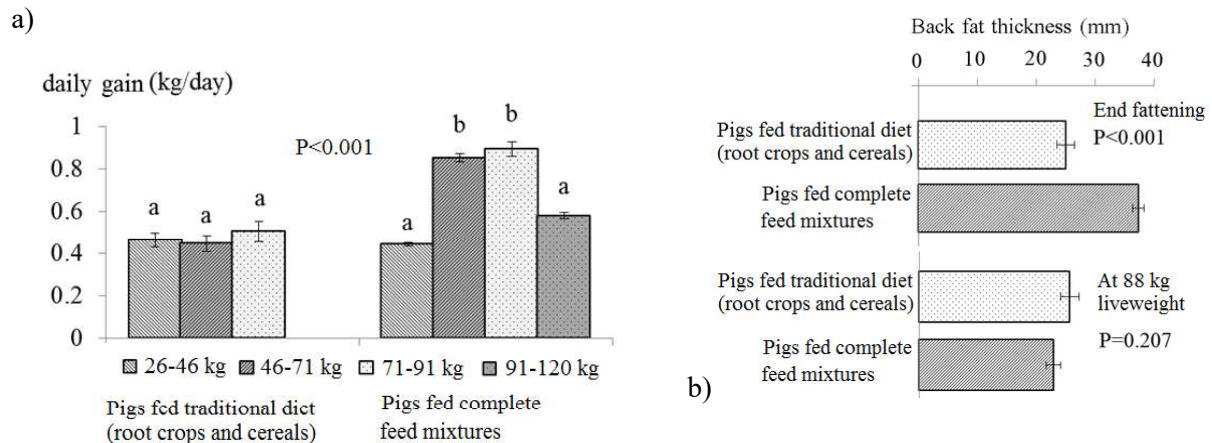
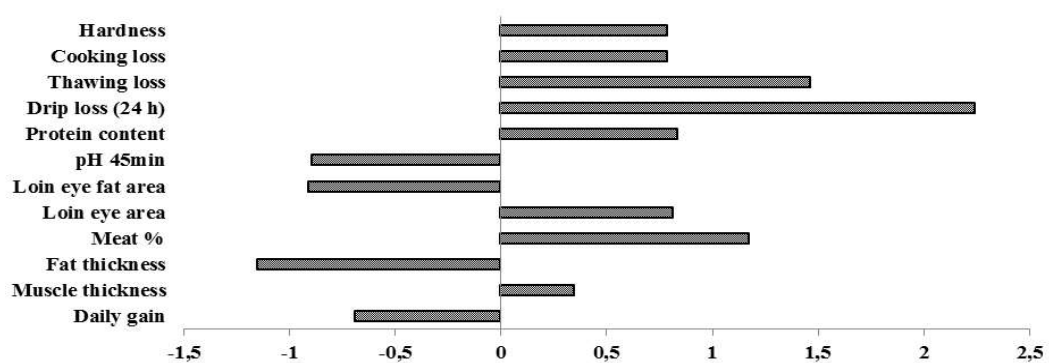


Figure 5: Daily gain (a) and backfat thickness (b) of pigs according to rearing system

Effect of the RYRI mutation in Krškopolje pigs

Pigs of N/n and N/N genotype at *RYRI* locus reared under the same conditions were compared. Pigs that carry mutated “n” allele exhibited slower growth rate, were more muscular, leaner and less fat and had reduced water holding capacity and increased hardness than N/N pigs (Figure 6) which agrees with the impact of the mutated “n” allele on muscularity and meat quality traits reported for modern white breeds (Monin *et al.*, 1999; Fisher *et al.*, 2000; Salmi *et al.*, 2010).



For variables presented in the Figure 6, the effect of “n” allele was significant ($P < 0.05$).

Figure 6: Effect size (of N/n vs. N/N) for carcass and meat quality traits

The quality of salami from Krškopolje pigs as compared to standard product

Using the same processing method, dry-cured sausages, made from meat and back fat of Krškopolje pigs differed from the sausages using usual raw material (conventional pig). Sausages from Krškopolje pigs had higher a_w than standard sausages (0.892 vs. 0.830, $P < 0.001$) despite similar moisture content (28.7 vs. 29.6%, $P = 0.090$). Value of pH was slightly lower in the sausages of Krškopolje pigs than the standard ones (6.00 vs. 6.09, $P = 0.109$). The sausages of Krškopolje pigs had less protein (23.1 vs. 29.9 %, $P < 0.001$), more fat (44.0 vs. 33.8 %, $P < 0.001$) but also less salt (3.9 vs. 5.5%, $P < 0.001$) than standard sausages. Differences in chemical composition were consistent with the sensory evaluation results showing that Krškopolje sausages were scored lower for colour intensity, mature smell and saltiness and their texture perceived as softer, more juicy, crumbly and pasty (Figure 7).

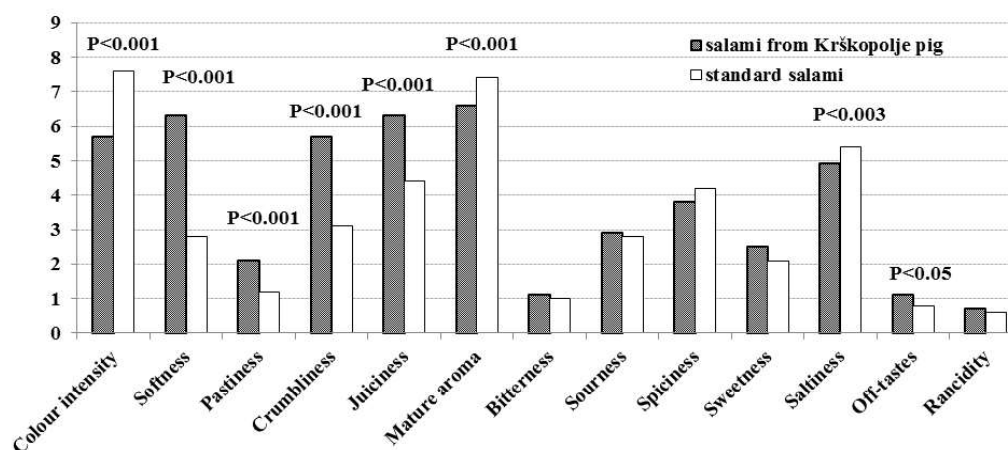


Figure 7: Differences in sensory profile of salami from Krškopolje pig and standard salami
Consumer preferences for salami from Krškopolje pigs

In a blind sensory test, standard salami was rated with a higher average rating scores compared to the salami from Krškopolje pig ($P = 0.003$; Figure 8). On the contrary, respondents showed a significantly better expected acceptability for Krškopolje salami ($P < 0.001$; Figure 8). When a sensory test with information about the product was applied (informed test), no difference in acceptability between the products was noted. According to the disconfirmation model, comparing results of blind and expected acceptability tests showed a negative disconfirmation for Krškopolje salami (the product is worse than expected; Figure 8). On the other hand, according to the assimilation model, higher scores of informed than of blind test for Krškopolje salami ($P < 0.001$; Figure 8) are showing a positive assimilation and putting in evidence that information about the breed can have a positive impact

on consumers' expectations about the tested product. Consumers showed higher acceptance when were informed about the product tasted. This finding highlights the importance of direct promotion and advertisement campaign that may give consumers the opportunity to know more about the breed.

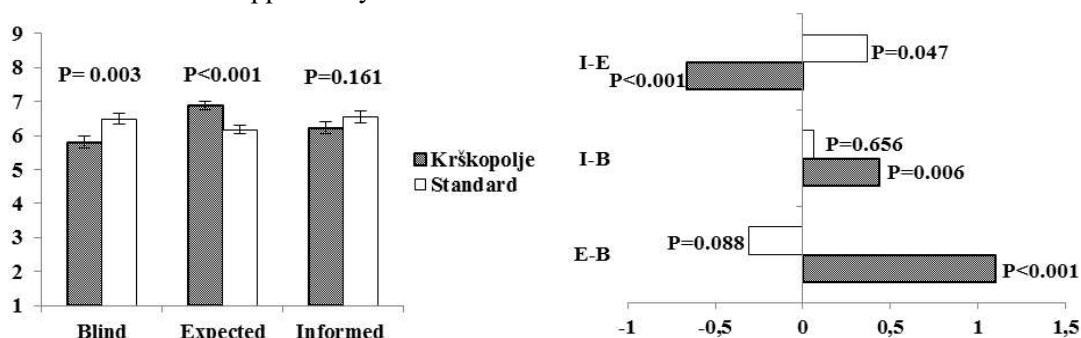


Figure 8: Results of sensory test and differences between expected (E) and blind (B), informed (I) and B, and I and E scores between standard salami and salami from Krškopolje pig

Conclusion

Preliminary results presented provide some basic information about the performances, productive traits and product quality of Slovenian local pig breed Krškopolje. Further studies are needed with regard to the growth potential according to the production system as well as for the purposes of developing adapted fattening systems. Krškopolje breed is facing a big challenge with the problem of high incidence of *RYRI* mutated allele that needs to be dealt with for the benefit of meat quality assurance. Studies with consumers show, that Krškopolje breed can have a positive impact on their expectations which highlights the importance of direct promotion.

Krškopoljska svinja u projektu TREASURE: od uzgoja do proizvoda

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Rezime

Krškopoljska svinja, slovenačka autohtona rasa, slabo je istražena i eksploatisana, kao što je slučaj kod mnogih autohtonih rasa svinja. Potrebno je više

saznanja o različitim aspektima od karakterizacije rase, performansama i kvalitetu proizvoda, te društveno-ekonomskom značaju za razvoj održivih lanaca njihovih proizvoda. Da bi odgovorili na ove izazove, studije se sprovode u okviru projekta H2020 TREASURE koji se proteže od praćenja do procene proizvoda. U ovom radu prezentovani su prvi parcijalni i preliminarni rezultati za krškopoljsku svinju koji se odnose na procenu performanse rasta u različitim sistemima uzgoja, efekat mutacije RYR1 gena i senzornog kvaliteta i prihvatljivosti novog tradicionalnog proizvoda (suva kobasica u tipu salame) od Krškopoljskih svinja.

Ključne reči: autohtona rasa, krškopoljska svinja, performanse rasta, RYR1 mutacija, suva kobasica, test potrošača

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