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INFLUENCE OF CRUDE PROTEIN LEVEL IN FORAGE MIXTURES ON PIG MEAT AND CARCASS QUALITY

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The research was conducted on pig carcasses and meat from two groups (A and B) of the Black Slavonian pigs (Croatian autochthonous, endangered breed), fed with a higher (group A) and a lower (group B) level of crude proteins in forage mixtures, during two fattening cycles (14%/12% and 12%/10%). In each group there were 16 pigs (8 gilts and 8 castrated male pigs). Increase in the crude protein level in forage mixtures had a very significant impact ($p<0.01$) on the reduction of the fat tissue share (34.55% : 39.09%) and on increase in the muscle tissue share (47.10% : 46.11%) in pig carcasses, although not to a statistically significant ($p>0.05$) extent. Pig carcasses from group A, compared to those in group B, had a significantly ($p<0.01$) higher share meat of ham (15.62% : 14.62%). Meat (MLD) of pigs from both of the groups was of very good quality, considering the analyzed indicators (pH_1, pH_2, water holding capacity, colour). Pig meat from group A, compared to meat from pigs in group B, had a statistically significant ($p<0.05$), higher level of crude proteins (21.47% : 20.93%), a very significantly ($p<0.01$) higher water content (70.62% : 65.70%), and lower level of crude fat (6.89% : 12.34%), while no significant differences ($p>0.05$) were determined between the analyzed groups of pigs in terms of the ash content (1.02% : 1.02%).

Key words: crude protein level; carcass quality; meat quality

ВЛИЈАНИЕ НА НИВОТО НА СУРОВИ ПРОТЕИНИ ВО КРМНИТЕ СМЕСКИ ВРЗ КВАЛИТЕТОТ НА СВИНСКИТЕ ПОЛУТКИ И МЕСОТО

Истражувањето е спроведено на свински полутки и месо од две групи (А и Б) кај црни славонски свињи (хрватска автохтона, загрозена раса), хранети со повисока (група А) и пониска (група Б) количина сурови протеини во крмните смески во текот на две фази на тов (14%/12% и 12%/10%). Во секоја група имаше 16 свињи (8 назимници и 8 кастрирани машки грла). Зголемувањето на количината на сурови протеини во смеските дејствуваше значително ($p < 0,01$) на намалување на уделот на масното ткиво (34,55% : 39,09%) и наголемување на уделот на мускулното ткиво (47,10% : 46,11%) во свинските полутки, иако не и статистички значајно ($p > 0,05$). Свинските полутки од групата А во однос на оние од групата Б имаа значително ($p < 0,01$) поголем удел на бутот (15,62% : 14,62%). Месото (MLD) на свињите од двете групи имаше многу добар квалитет со оглед на анализираните показатели (pH_1, pH_2, способност за врзување на вода, боја). Месото од свињите од групата А, во однос на тоа од групата Б, имаше значително ($p < 0,05$) повисока содржина на сурови протеини (21,47% : 20,93%), многу значително ($p < 0,01$) повисока содржина на вода (70,62% : 65,70%), а помала содржина на сурови масти (6,89% : 12,34%), додека во поглед на содржината на пепел (1,02% : 1,02%) не се утврдени значајни разлики ($p > 0,05$) помеѓу анализираните групи свињи.

Клучни зборови: количина на сурови протеини; квалитет на полутки; квалитет на месо

1. INTRODUCTION

Quality of pig meat and carcasses depends on interaction between genetic and paragenetic factors. Among paragenetic factors, food quality and quantity is, in addition to the final body weight of pigs, one of the most important factors influencing the slaughterhouse quality of pigs. Crude protein

level in forage mixtures during fattening influences not only the quality of pig carcasses, but also the quality of muscle tissue, that is, meat (Nieto et al., 2003; Millet et al., 2006; Barea et al., 2008**)**. In the available literature there are no data on the influence of crude protein level in forage mixtures on the phenotype expression of meatiness of the Black Slavonian pig, an autochthonous Croatian breed of lard and the meat type. The Black Slavonian pigs have been fed empirically so far, without exact research conducted on their real nutritional needs.

2. MATERIAL AND METHODS

Research was conducted on pig carcasses and meat of 16 Black Slavonian pigs fattened up to 130 kg body weight with a higher crude protein level in forage mixtures (Group A), and on pig carcasses and meat of 16 Black Slavonian pigs fattened up to the same body weight, but with a lower crude protein level in forage mixtures (Group B). Sex ratio (barrows and gilts) was the same in each group. Pigs in Group A were fed forage mixture with 14.00 % crude protein and 13.37 MJ ME/kg in the period from 30 to 60 kg body weight, and with forage mixture with 11.88% crude protein and 13.34 MJ ME/kg in the period from 60 to 130 kg body weight, as well as with fresh green alfalfa, which were both fed ad libitum. Pigs in Group B were fed forage mixture with 12.13 % crude protein and 13.34 MJ ME/kg in the period from 30 to 60 kg body weight, and with forage mixture with 10.09% crude protein and 13.00 MJ ME/kg in the period from 60 to 110 kg body weight. Pigs from both analyzed groups were kept in the semi-outdoor system with the same housing and feeding conditions, during the summer-autumn season.

Dissection of right sides of cooled pig carcasses (+4ºC) was conducted according to the modified method of Weniger et al. (1963). According to this modification, the total quantity of muscle tissue does not include muscle tissue of head, which was not dissected.

pH value of meat was determined 45 minutes post mortem, and pH_2 value 24 hours post mortem, by means of a contact pH meter Mettler Toledo. The meat quality was determined on the sample from *M. longissimus dorsi*, taken between the 13th and the 14th rib. The water holding capacity of meat was determined according to Grau and Hamm (1952), and the colour ("L", "a" and "b" values) was determined using a Minolta CR-410 Chromameter. The research results were processed according to the LSD test system softwork stastistica (Stat Soft. Inc., 2008).

3. RESULTS AND DISCUSSION

Data in Table 1 show that there are significant differences in conformation of the Black Slavonian pig carcasses in relation to the crude protein level in forage mixtures.

Table 1

Pig carcass conformation in relation to crude protein level in forage mixtures

Indicators	Statistical value	Crude protein level	
		A (higher)	B (lower)
Body mass, kg	$\bar{x}$	130.37	130.40
	s	6.84	6.70
Cold carcass mass, kg	$\bar{x}$	51.08	51.22
	s	3.87	4.39
Less valuable parts, %	$\bar{x}$	8.86**	7.37
	s	0.73	0.75
Jowl, %	$\bar{x}$	2.00**	2.53
	s	0.39	0.32
Fat, %	$\bar{x}$	2.78**	4.81
	s	0.54	1.36
Neck,%	$\bar{x}$	13.34**	6.69
	s	2.04	1.14
Back part, %	$\bar{x}$	14.73	14.96
	s	1.18	1.18
Shoulder, %	$\bar{x}$	11.07**	14.36
	s	0.81	2.91
Ham, %	$\bar{x}$	26.55**	24.62
	s	1.42	1.08
Abdominal-rib part, %	$\bar{x}$	20.64**	24.69
	s	1.08	1.05

**p<0.01

Pig carcasses from Group A (higher crude protein level in forage mixtures) had a significantly ($p < 0.01$) smaller relative share of fat parts – jowl and lard as well as abdominal-rib part and shoulder – and a very significantly ($p < 0.01$) higher share of ham and neck, in relation to pig carcasses from Group B (lower crude protein level in forage mixtures). No significant differences were detected between the analyzed groups in terms of the back part ($p > 0.05$).

Pig carcasses from Group A had a somewhat higher share of muscle tissue in relation to those from Group B, but the difference was not statistically significant ($p > 0.05$), while there was an absolute and relative very significantly ($p < 0.01$) higher share of bones determined. Pig carcasses from Group B had an absolute and relative very significantly ($p < 0.01$) higher share of fat tissue (Tables 2 and 4).

Investigating the effects of four levels of crude proteins in feed of Iberian pigs, Barea et al. (2008) have determined a small, but significant influence of protein level on pig carcass composition. Increased fat depositing was observed on pigs fed lower protein level feed. Feeding rations with three protein levels (high, medium, low) to pigs in organic production, Millet et al. (2007) determined the lower meat percentage in pig carcasses when these were fed rations with lower protein level, while the influence on meat quality was limited.

In addition to the share of muscle tissue, distribution of muscle tissue in carcasses is also very important, because not all parts have the same utilization and commercial value. The relative share of meat in individual basic joints of pig carcasses in relation to crude protein level in forage mixtures is shown in the Table 2.

Table 2

Share of meat in pig carcasses in relation to the crude protein level in forage mixtures

Indicators	Statistical value	Crude protein level	
		A (higher)	B (lower)
Body weight of cold pig carcasses, kg	$\bar{x}$	51.08	51.22
	s	3.87	4.39
Share of meat in carcasses, %	$\bar{x}$	47.16	46.11
	s	2.25	3.54
Share of neck meat, %	$\bar{x}$	8.02**	4.68
	s	1.13	0.75
Share of loin meat, %	$\bar{x}$	6.34**	7.21
	s	0.93	0.82
Share of shoulder meat, %	$\bar{x}$	6.25**	8.62
	s	0.58	1.60
Share of ham meat, %	$\bar{x}$	15.62*	14.62
	s	1.38	1.10
Share of meat in belly-rib part, %	$\bar{x}$	10.93	10.98
	s	0.64	1.74

*p < 0.05 **p < 0.01

A significantly ($p < 0.05$) higher share of ham meat and a very significantly ($p < 0.01$) higher share of neck meat were determined in carcasses of pigs fed with forage mixture with a higher crude protein level. In carcasses of pigs that were fed forage mixture with a lower crude protein level, a very significantly ($p < 0.01$) higher share of loin and shoulder meat was a determined. No significant ($p > 0.05$) differences between the analyzed groups were detected in terms of share of meat in the belly-rib part of pig carcasses.

The composition of the main basic joints of pig carcasses in relation to the crude protein level in forage mixtures is shown in Table 3.

Table 3

Composition of the main basic parts of pig carcasses in relation to the crude protein level in forage mixtures

Joint of carcass	Tissue	Statistical value	Crude protein level			
			A (higher)		B (lower)	
			kg	%	kg	%
Leg	Muscle	$\bar{x}$	7.95	58.81	7.49	59.49
		s	0.62	3.42	0.86	3.16
	Fat	$\bar{x}$	4.17**	30.76	3.94	31.29
		s	0.58	3.09	0.38	3.32
	Bone	$\bar{x}$	1.42**	10.43**	1.16	9.21
		s	0.22	1.06	0.17	1.04
Loin	Muscle	$\bar{x}$	3.23**	42.98**	3.71	48.21
		s	0.41	4.32	0.66	3.50
	Fat	$\bar{x}$	3.27	43.46	3.11	40.59
		s	0.58	6.02	0.42	3.14
	Bone	$\bar{x}$	1.02*	13.56*	0.86	11.20
		s	0.25	3.11	0.20	2.01
Shoulder	Muscle	$\bar{x}$	3.19**	56.41**	4.43	60.44
		s	0.38	2.73	0.96	2.81
	Fat	$\bar{x}$	1.62**	28.60	2.22	28.81
		s	0.28	3.03	0.76	6.69
	Bone	$\bar{x}$	0.84**	14.09*	0.73	10.74
		s	0.04	2.01	0.09	4.30

*p < 0.05 **p < 0.01

In terms of an absolute and relative share of muscle tissue in ham, no significant ($p > 0.05$) differences were detected between the pigs from Group A and Group B, although the pigs from Group A had a significantly higher share of ham meat in carcasses. Loin and shoulder had a very significantly ($p < 0.05$) higher absolute and relative share of muscle tissue in carcasses of the pigs

from Group B, which were fed with a lower crude protein level in forage mixtures.

In the research conducted by Nieto et al. (2003), reduction of the crude protein level in pig rations led to increased fat in shoulder and ham and to reduction of proportional share of shoulder in carcasses. However, Barea et al. (2008), did not determine the influence of the protein level in pig rations on the contents of intramuscular and subcutaneous fat tissue in ham and shoulder.

Table 4

Shares of tissue in pig carcasses in relation to the crude protein level in forage mixtures

Tissue	Statistical value	Crude protein level			
		A (higher)		B (lower)	
		kg	%	kg	%
Muscle	$\bar{x}$	24.06	47.10	23.64	46.11
	s	1.56	2.25	3.04	3.54
Fat	$\bar{x}$	17.65**	34.55**	20.01	39.09
	s	2.33	2.62	2.35	3.47
Bone	$\bar{x}$	4.85**	9.49**	3.90	7.43
	s	0.54	0.94	0.60	0.71

**p < 0.01

Pig meat quality in relation to the crude protein level in forage mixtures is shown in the Table 5.

Pig meat from Group A (higher crude protein level) had a significantly ($p < 0.05$) lower pH_2 value and a very significantly ($p < 0.01$) lower water holding capacity in relation to the meat of pigs from Group B (lower crude protein level). Meat from both analyzed groups had a standard initial pH_1 and final pH_2 value. Values of the final pH below 5.5 indicate the occurrence of PSE meat (Forrest, 1998). Values of the final pH above 6.0 are a certain sign of dark, firm and dry (DFD) meat (Hofmann, 1994).

Meat colour parameters (L*, a*, and b* values) also indicate the standard meat quality. L* value indicates meat lightness, a* value indicates meat redness, and b* value indicates meat yellowness. Since the occurrence of the PSE syndrome is the largest meat defect, the most important data when evaluating meat colour is the level of its lightness (L*). Desired values of meat lightness range from 43–50 (Joo et al., 1999). L* values above 50 indicate pale, soft and exudative (PSE) meat, and L* values below 43 indicate dark, firm and dry (DFD) meat.

Table 5

Pig meat quality in relation to the crude protein level in forage mixtures

Indicators	Stat. size	Crude protein level	
		A (higher)	B (lower)
pH_1	$\bar{x}$	6.23	6.47
	s	0.27	0.21
pH_2	$\bar{x}$	5.61*	5.75
	s	0.20	0.19
Water holding capacity, cm^2	$\bar{x}$	4.65**	3.06
	s	1.64	1.33
Colour (L* value)	$\bar{x}$	51.15**	48.27
	s	2.41	4.35
Colour (a* value)	$\bar{x}$	18.43*	19.28
	s	1.22	0.95
Colour (b* value)	$\bar{x}$	6.04	5.47
	s	0.99	1.23
Consistency, cm^2	$\bar{x}$	2.58	2.15
	s	0.76	0.42
Crude proteins, %	$\bar{x}$	21.47*	20.93
	s	0.72	0.84
Crude fat, %	$\bar{x}$	6.89**	12.34
	s	2.81	3.48
Ash, %	$\bar{x}$	1.02	1.02
	s	0.04	0.05
Water, %	$\bar{x}$	70.62**	65.70
	s	1.21	2.75

*p < 0.05 **p < 0.01

Water holding capacity of meat, expressed as the area of filter paper wetness around the compressed meat sample, was also standard in both analyzed groups and better than the one earlier determined for pig breeds of meat type and their crossbreds (Senčić et al., 2002.; Senčić et al., 2003; and Senčić et al., 2005).

Muscle tissue consistency, expressed as the area of filter paper wetness below compressed meat, was also standard and no significant differences were detected between the analyzed groups.

The crude protein level in forage mixtures also significantly influenced the chemical compo-

sition of meat. Meat of pigs that were fed forage mixtures with higher crude protein level (Group A) had a significantly ($p < 0.05$) higher content of crude proteins, a very significantly ($p < 0.01$) higher water content, and a very significantly ($p < 0.01$) lower content of crude fat in relation to meat of pigs that were fed forage mixtures with lower crude protein level (Group B). No significant differences ($p > 0.05$) were detected between the analyzed groups in terms of ash content.

4. CONCLUSION

The increased crude protein level in forage mixtures had a very significant ($p < 0.01$) influence on the reduction of the fat tissue share (34.55% : 39.09%) and on increase in the muscle tissue share (47.10% : 46.11%) in pig carcasses, although not to a statistically significant extent ($p > 0.05$). Pig carcasses from Group A (higher crude protein level) in relation to those from Group B (lower crude protein level) had a significantly ($p < 0.01$) higher share meat of ham (15.62% : 14.62%). Meat (MLD) of pigs from both groups was of very good quality, considering the analyzed indicators (pH_1, pH_2, water holding capacity, and colour). The meat from the Group A pigs, in relation to the meat from the Group B pigs, had a significantly ($p < 0.05$) higher crude protein content (21.47% : 20.93%), a very significantly ($p < 0.01$) higher water content (70.62% : 65.70%), and lower crude fat content (6.89% : 12.34%), while in terms of ash (1.02% : 1.02%) no significant differences ($p > 0.05$) were detected between the analyzed groups of pigs.

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