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Estimation of selected porcine meat quality indicators on the basis of electrical conductivity measured 24 hours post-slaughter

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Correlations were estimated between the single measurement of electrical conductivity (EC) done 24 h post-slaughter and meat pH_{45} and pH_{24}, water, protein and intramuscular fat content, thermal drip and free-water content and meat texture (tenderness and juiciness). Used were 43 carcasses of castrates. Once the animals reached the mean final body weight of about 105 kg, they were slaughtered at one slaughter house in accordance with technological standards adopted in meat processing plants. With the increase in EC measured 24 hours post-slaughter, both the initial (pH_{45}) and final (pH_{24}) meat acidities decreased. Moreover, together with the EC_{24} increase, the water level of meat decreased and was accompanied by an increase in the protein content. Increased EC resulted in increased thermal and free water drips which, in turn, reduced meat juiciness. Phenotypic correlation coefficients were estimated between EC measured 24 h post-slaughter and pH_{45} (-0.756), water content (-0.359*), protein content (0.476**), thermal drip (0.331*), free-water content (0.373*) and juiciness (-0.342*). It is concluded that in the synthetic line 990 fatteners the EC of meat measured 24 h post-slaughter can be employed in practice for rapid diagnosis of pork quality on the slaughter line.**

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KEY WORDS: electrical conductivity / meat quality / pigs / porcine meat

Culinary meat quality is an important meat trait characteristic from the point of view of ordinary consumers [Byrne *et al*. 2000]. It is widely accepted that there is a negative correlation between the meat quality and meat content of carcass [Wajda 1998, Pośpiech and Borzuta 1998, Wajda and Denaburski 2003, Łyczyński *et al*. 2002, Borzuta 2004]. Consumers' requirements concerning the quality of offered porcine meat and porcine meat products continue to increase. Rapid assessment of quality makes it possible to select pork sufficiently early for either culinary or processing purposes [Blicharski *et al*. 1995, Byrne *et al*. 2000, Lee *et al*. 2000, Strzelecki *et al*. 1995, Antosik *et al*. 2003, Borzuta *et al*. 2004, Łyczyński *et al*. 2005, 2007].

The present investigation aimed at determining, in the meat of fatteners of the synthetic Line 990, correlations between the single electrical conductivity measurement taken 24 hours post-slaughter and meat pH_{45} and pH_{24}, content of water, protein and intramuscular fat, thermal drip, free water content and meat texture (tenderness and juiciness).

Material and methods

Used were 43 pig carcasses of Line 990 fatteners (castrates). The animals of the body weight of about 15 kg, were purchased from the Main Pig Hybridization Centre in Pawłowice and placed in the Experimental Station of Animal Nutrition in Gorzyń belonging to the Department of Animal Nutrition and Feed Management of the Poznan University of Life Sciences. During the period of rearing and fattening, animals were kept in identical environmental conditions.on straw litter in a stall system and fed *ad libitum* two types of complete diets balanced with regard to their protein-energetic composition and prepared specially for purposes of this study.

During the rearing period (15 to 30 kg body weight), the piglets were kept in pens, two animals in each, and fed *ad libitum* a complete ration of Grower type, balanced with regard to protein-energetic composition and containing 13.0 MJ metabolic energy and 18% crude protein supplied with crystalline amino acids.

The entire fattening period started from the body weight of 30 kg and lasted to 105 kg live weight. During the first subperiod of fattening*, i.e*. from 30 to 65 kg live weight, the animals were fed complete diet, containing 13.5 MJ metabolic energy and 18.5% crude protein balanced with crystalline amino acids. During the second subperiod, *i.e*. from 65 kg to 105 kg live weight, the pigs were fed complete diet containing 12.5 MJ metabolic energy and 16.0% crude protein balanced with amino acids. Once the pigs reached the mean final body weight of about 105 kg, they were slaughtered at one slaughter house in accordance with technological standards adopted in meat processing plants. Meat quality was assessed in the *longissimus lumborum* (LL) muscle on the basis of the following measurements: electrical conductivity (EC – a single measurement made 24 hours post-slaughter), pH_{45} and pH_{24}, content of

water, protein and intramuscular fat, technological parametres (thermal drip and free water content – WHC) as well as selected parametres of consumers' meat assessment (tenderness and juiciness). Electrical conductivity (EC_{24}) was determined using an LF-STAR apparatus (MATTHÄUS). Meat pH_{45} and pH_{24} were determined using a Handylab 2 apparatus (SCHOTT GERÄTE). The content of water (%) was determined with dryer method, that of fat with Soxhlet metod and that of protein with Kjeldahl method (according to Polish Standards). Thermal drip was determined according to Janicki and Walczak [Znaniecki 1983], while free-water content (WHC) – using the method of Grau and Hamm [1952] as modified by Pohia and Niniivaara [1957]. Meat sensory assessment (tenderness and juiciness) was carried out in 10 point scale as proposed by Baryłko-Pikielna [1975].

LL samples for the determination of meat technological parametres (thermal drip and WHC) as well as meat texture (tenderness and juiciness) were collected after 24 hours of chilling from the left carcass-sides below the last thoracic vertebra in the lumbar direction, packed into foil bags and transferred in cold into the laboratory for analyses. Following the assessment of meat EC_{24} on the slaughter line, the obtained measurement results were arbitrarily divided into three groups: <4.99 mS/cm, from 5.00 to 7.00 mS/cm and >7.00 mS/cm assigning respective values of the analysed meat quality traits to each group.

The results were subjected to statistical evaluation by the STATISTICA software using single-factor analysis of variance. Moreover, estimated were phenotypic correlation coefficients between the assessed parametres of meat quality traits.

Results and discussion

Table 1 shows the statistical parametres of meat quality indicators in fatteners of the whole group (n=43), while Table 2 presents means of the analysed meat traits as

Table 1. Means and their standard deviations (SD) for meat quality traits in line 990 fatteners (n=43)

Trait	Mean	SD
Electric conductivity 24 h *post-mortem*	5.58	2.59
$pH_{45'}$	6.36	0.47
pH_{24h}	5.52	0.17
Water content (%)	74.25	0.84
Total protein content (%)	22.74	0.85
Intramuscular fat content (%)	2.20	0.87
Thermal drip (%)	26.87	3.03
Free-water content (%)	36.52	4.77
Tenderness (points)	6.21	1.20
Juiciness (points)	6.29	1.60

Table 2. Means and their standard deviations (SD) for meat quality traits in line 990 fatteners as related to meat electric conductivity 24 h *post-mortem*

Trait	Range in electrical conductivity					
	<4.99 mS/cm (n=….)		5.00-7.00 mS/cm (n=….)		>7 mS/cm (n=….)	
	mean	SD	mean	SD	mean	SD
Electric conductivity 24 h *post-mortem*	3.94^{AB}	0.59	6.14^{AC}	0.49	10.31^{BC}	1.69
$pH_{45'}$	6.52^{A}	0.20	6.52^{B}	0.35	5.64^{AB}	0.57
pH_{24h}	5.52	0.16	5.60^{a}	0.20	5.42^{a}	0.10
Water content (%)	74.45^{a}	0.76	74.16	0.98	73.67^{a}	0.76
Total protein content (%)	22.53^{A}	0.76	22.49^{B}	0.76	23.67^{AB}	0.65
Intramuscular fat content (%)	2.23	0.96	2.35	0.90	1.91	0.41
Thermal drip (%)	26.37^{a}	2.54	26.24^{b}	3.79	29.22^{ab}	2.78
Free-water content (%)	35.95^{A}	4.51	34.47^{B}	4.64	40.70^{AB}	3.60
Tenderness (points)	6.13	1.26	6.53	1.30	6.11	0.90
Juiciness (points)	6.46^{A}	1.52	7.08^{B}	1.51	4.84^{AB}	1.09

$^{aA...}$Within lines means bearing different supercripts differ significantly at: small letters – P≤0.05; capitals – P≤0.01.

related to three individual groups of EC measured 24 hours post-slaughter. The rise in meat EC was shown to be significantly related primarily to meat pH_{45} and pH_{24}, water and protein content, thermal and free water drips and meat juiciness. Together with the increase of meat EC in three intervals of its values (<4.99, 5.00-7.00 and >7.00 mS/cm) measured 24 hours post- slaughter of animals a significant decline in the initial (pH_{45}) and final (pH_{24}) was observed as well as in the water content of meat, while the content of meat protein increased. Analysing technological parametres, it was found that with the increase of EC, increase of both thermal drip and free-water content took place. The observed increase in drips exerted a significant impact, among others, on reduced meat juiciness.

Table 3 presents phenotypic correlations between the analysed meat quality traits. The highest and highly significant correlation coefficients (*r*P) were found between the meat pH_{24} and free-water content (-0.832**) and meat juiciness (0.728**), between electrical conductivity (EC_{24}) and meat pH_{45} (-0.756**), between free-water content and meat juiciness (-0.723**) and between meat tenderness and meat juiciness (0.633**). The obtained high *r*P indicators confirm that they characterize the quality of the obtained pork in the right way.

Strzelecki *et al*. [1995] demonstrated that the first measurement of meat EC carried out 90 min post-slaughter allowed to determine only meat of typical PSE symptoms. On the other hand, they maintained that the EC measurement made 24 hours rather than 90 min post-slaughter was a much better indicator of meat quality on the slaughter line, which is in accordance with the results of the present study.

The obtained values of the analysed meat quality traits were within the ranges reported by other authors [Łyczyński *et al*. 2002, 2005, 2006, Pospiech 2000,

Table 3. Phenotypic correlations between analysed porcine meat quality traits

Trait	$pH_{45'}$	pH_{24h}	Water (%)	Intramuscular fat (%)	Total protein (%)	Thermal drip (%)	Free-water (%)	Tenderness (points)	Juiciness (points)
Electric conductivity 24 h *post-mortem*	-0.756**	-0.210	-0.359*	-0.144	0.476**	0.331*	0.373*	0.02	-0.342*
$pH_{45'}$		0.444**	0.349*	0.209	-0.533**	-0.462**	-0.569**	0.204	0.527**
pH_{24h}			0.044	0.135	-0.242	-0.418**	-0.832**	0.362*	0.728**
Water content (%)				-0.442**	-0.217	-0.056	-.0.162	0.063	0.067
Intramuscular fat content (%)					-0.435**	-0.292	-0.059	0.369*	0.342*
Total protein content (%)						0.340*	0.226	-0.123	-0.384*
Thermal drip (%)							0.451**	-0.358*	-0.382*
Free-water content (%)								-0.384*	-0.723**
Tenderness (points)									0.633**
Juiciness (points)									

*P≤0.05, **P≤0.01.

Pospiech *et al*. 2002, Antosik *et al*. 2003]. Our results, on the one hand, confirm that the classification of porcine meat proposed by Pospiech and Borzuta [1998] and Borzuta [2004] was correct and, on the other, show that meat EC measured 24 hours post-slaughter can be used for rapid diagnosis of pork quality on the slaughter line as demonstrated, among others, by Blicharski *et al*. [1995], Strzelecki *et al*. [1995], Borzuta *et al*. [2002], Pospiech *et al*. [2002], Antosik *et al*. [2003], Borzuta *et al*. [2004], Łyczyński *et al*. [2005, 2007]. Its increase above 7 mS/cm in the group of carcasses with electrical conductivity measurements taken 24 hours after slaughter obtained in this study caused a distinct worsening of the analysed technological parametres and meat texture. Hence, it turned out to be a more favourable indicator in the assessment of meat quality than the measurement of EC carried out 90 min post-slaughter as indicated among others by Strzelecki *et al*. [1995], Borzuta *et al*. [2002], Pospiech *et al*. [2002], Antosik *et al*. [2003], Borzuta *et al*. [2004], Łyczyński *et al*. [2005, 2007]. Therefore, the measurement of EC done 24 hours post-slaughter of fatteners can be used in practice for rapid porcine meat evaluation on the slaughter line.

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Wybrane parametry jakości mięsa wieprzowego szacowane na podstawie pomiarów jego przewodności elektrycznej mierzonej 24 h po uboju

S t r e s z c z e n i e

Oceniono zależności między przewodnością elektryczną (EC) mięsa mierzoną jednorazowo 24 h po uboju zwierząt a pozostałymi wyróżnikami jakościowymi mięsa: pH po 45 minutach i 24 godzinach od uboju (pH_{45} i pH_{24}), zawartością wody, białka i tłuszczu śródmięśniowego, wyciekiem termicznym i wyciekiem wody luźnej (WHC) oraz teksturą (kruchość i soczystość). Materiał stanowiły 43 tusze wieprzków linii 990. Po uzyskaniu przez zwierzęta średniej końcowej masy ciała około 105 kg, poddano je ubojowi w jednym zakładzie, według standardowych norm technologicznych, przyjętych w zakładach mięsnych. Stwierdzone wartości EC zaliczono do jednej z trzech grup: <4,99, 5,00-7,00 i >7,00 mS/cm (odpowiednio grupa 1, 2 i 3). Rosnącym wartościom średnim przewodności elektrycznej w grupach od 1 do 3 towarzyszył spadek początkowego i końcowego odczynu mięsa (odpowiednio pH_{45} i pH_{24}). Ponadto, ze wzrostem EC zmniejszała się zawartość wody w mięsie, a rosła zawartość w nim białka oraz następował wzrost wycieku termicznego i wycieku wody luźnej, co istotnie wpływało na obniżenie soczystości mięsa. Oszacowano istotne korelacje fenotypowe (*rP*) między EC a pH_{45} (-0,756**), zawartością wody (-0,359*), białka (0,476**), wyciekiem termicznym (0,331*), wyciekiem wody luźnej (0,373*) oraz soczystością (-0,342*) mięsa. Autorzy wnioskują, że pomiar przewodności elektrycznej mięsa świń linii 990, dokonywany po 24 godzinach od uboju, może być wykorzystywany w praktyce do szybkiego diagnozowania jakości wieprzowiny na taśmie ubojowej.