ELECTRICAL CONDUCTIVITY OF PIG MEAT AND ITS RELATION WITH QUALITY

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Summary. Electrical conductivity of the muscles of two pigs (*m. longissimus dorsi and m. semimembranosus*) was investigated 45, 60, 90, 120 and 150 minutes, and 24 h and 48 h after slaughter. The correlation coefficients between muscle physical-chemical properties and electrical conductivity of meat at different periods were calculated. It was established that the highest correlation coefficients were between the electrical conductivity 45 minutes after slaughtering and meat pH (r = 0.56), meat water binding capacity (r = 61) and meat hardness (r = 0.49). With increasing time after slaughter, the correlation coefficients were decreasing. It is concluded that determining electrical conductivity of meat during the first 45-50 minutes post-mortem can be used as a method for separation of pig carcasses with PSE and DFD defects.

Keywords*:* muscles, pig, electrical conductivity, meat quality.

KIAULIENOS ELEKTROS LAIDUMAS IR JO RYŠYS SU KOKYBE

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Santrauka. Tirtas kiaulių raumenų (ilgiausiojo nugaros raumens ir pusplėvinio raumens) elektros laidumas praėjus 45, 60, 90, 120, 150 minučių ir 24 bei 48 valandoms po skerdimo. Taip pat tirtos ilgiausiojo nugaros raumens fizinės ir cheminės savybės praėjus 48 val. po skerdimo. Apskaičiuoti koreliacijos koeficientai tarp raumens fizinių bei cheminių savybių ir mėsos elektros laidumo įvairiais laikotarpiais. Nustatyta, kad aukščiausi koreliacijos koeficientai buvo tarp elektros laidumo ir mėsos pH (r=0,56), mėsos vandens rišlumo (r=61) ir kietumo (r=0,49) praėjus 45 min. po paskerdimo. Ilgėjant laikui po skerdimo koreliacijos koeficientai mažėja. Daroma išvada, kad mėsos elektros laidumas per pirmąsias 45–50 min. po skerdimo gali būti pritaikytas kaip metodas, atskiriant kiaulių skerdenas su PSE ir DFD defektais.

Raktažodžiai: mėsa, kiaulė, elektros laidumas, mėsos kokybė.

Introduction. The main materials necessary for the human body to maintain its vital functions are located in meat and meat products as proteins, fats and other lipids, carbohydrates, minerals, and vitamins. These materials are of ideal proportions, and easily tolerated by the human body. The nutritional value of meat depends on its quality. The meat quality is described by sensory, sanitary-hygienic, technological and nutritional indicators (Zajas, 1981). The mentioned indicators are influenced by animal type, breed, individual characteristics, gender, age, production technology, body condition and other factors (Sallier et al. 1994; Lee et al. 2000; Popov, 2005; Burmistrov et al. 2005; Коптелова et al. 2005; Lyczynski et al. 2007). Knowledge of these factors and purposeful human activity organization helps to improve the animal meat characteristics and meat quality. The productivity of animals and the quality of products depend on the the genotypic and phenotypic factors. These factors are interdependent and inseparable. For improvement of the animal genotype, it is necessary to create adequate conditions for realization of these genotypes (Schworer et al. 1994; Šilov et al. 2002).

In order to improve meat quality the selection of animals and new evaluation methods are used (Lengerken et al. 1991; Demo et al. 1993; Lepetit et al. 2002; Jukna et al. 2006; Jukna et al. 2008).

In recent years, the interest in electrical conductivity of meat and its relationship with some of the meat quality traits (Swantek et al. 1992; Stupka et al. 1993; Slanger and Marchello 1994; Byrne et al. 2000; Norman et al. 2000; Antosik et. al. 2003; Lepetit et al. 2002; Jukna et al. 2008) has been increasing.

Pork production has been increasing all over the world. Therefore, much attention is paid to improvement of its quality characteristics. In many countries, pigs are selected not only according to the fattening rates of the offsprings but also according to the meat quality indicators. It is rather important to determine the link between the muscle development and meat quality parameters (Schworer et al. 1994; Šilov et al. 2002; Pospiech et al. 2006).

As a result of the concentration and industrialization of swine production and increasing number of specialized pig breeds, an increasing number of animals have gray and watery meat (PSE), which is hardly suitable for trading high quality products. Also some animals have hard, dry and dark meat (DFD). Yet for this kind of meat there is no demand. These unwanted characteristics of meat also can depend on the genotype of pigs and is quite a problem in modern swine-breeding (Соловьев, 2000; D'Souza et al. 2000).

One of the meat quality parameter is electrical conductivity of meat. However, the data about the link between muscle electrical conductivity and meat quality parameters are rather scanty.

The aim of this study is to investigate porcine muscle electrical conductivity changes after a varying period of time after slaughter and to determine its relationship with meat quality indicators.

Material and methods. The experiment was carried out with 70 Lithuanian Large White pigs 90–110 kg body mass. Meat assay was performed in the meat processing plants and in the Lithuanian Veterinary Academy, Laboratory of Meat Characteristics and Quality Assessment. The muscle electrical conductivity was assessed in *m. longissimus dorsi* at the last rib and *m. semimembranosus* in the middle using the German device LF / pt.-STAR-CUP. The sample for the meat quality determination was taken from *m. longissmus dorsi* at the last two ribs.

Muscle electrical conductivity (EL) was assessed 45, 60, 90, 120, and 150 minutes and 24 and 48 hours after slaughter. Meat quality parameters (dry matter, protein, fat, pH, firmness, cooking loss, water binding capacity, and color) were determined in accordance with the generally accepted methods, within 48 hours after slaughter.

Meat pH was detected with a pH-meter "INOLAB3", the dry matter was measured by the automatic scale for humidity assessment Scaltec SMO – 01, the drip loss of meat was determined after keeping it in refrigerator for 24 hours in special bags, the color of meat was measured by Fuison Kirsamer method, the water binding capacity by R. Grau and Hamm method, and the cooking loss was determined by cooking meat in the circulating bath at 70°C. The shear force was established by Warner-Bratzler method and fat by an automatic system for fat extraction Soxterm SE 416 macro.

Statistical analysis*:* The R statistical package version 2.0.1. (Gentlemen, Ihaka, 1997) was used to estimate the obtained data.

Results and discussion*:* Analysis has shown that electrical conductivity in muscles during the fermentation processes after slaughter changes (Table 1).

Table1. **Electrical conductivity changes in muscle occurring at different time spans after the slaughter,** mS

Muscles	Indicators	Time after the slaughter						
		45 minutes	60 minutes	90 minutes	120 minutes	150 minutes	24 h	48 h
M. longissimus dorsi	$\overline{X}$	1.75	1.68	1.61	1.81	1.96	6.95	10.62
	Sx	0.06	0.05	0.09	0.12	025	0.43	0.32
	minimum	1.36	1.12	1.03	1.00	1.07	2.39	5.68
	maximum	3.47	2.52	3.75	5.30	11.04	13.56	14.26
M. semimembranosus	$\overline{X}$	2.33	2.35	2.19	2.44	2.60	4.63	27.54
	Sx	0.10	0.10	0.09	0.12	0.14	0.31	0.27
	minimum	1.02	1.10	1.03	1.31	1.47	2.13	23.36
	maximum	4.14	4.16	3.75	4.99	6.12	8.70	30.46

Electrical conductivity of the muscles during meat maturation increases. Electrical conductivity mS of *M. longissimus dorsi* 24 hours after slaughter increased by 3.76 times (P <0.001) and of the *m. semimembranosus* by 1.99 times (P <0.001) compared with the data obtained 45 minutes after slaughter. Electrical conductivity continued to increase until meat reached maturity 48 hours after the slaughter. According to the data of R. Matthäus engineering office in Germany (1994), the normal pork electrical conductivity 45 minutes after slaughter was <4.3 mS, but in the PSE muscle it was > 8.3 45 minutes and 12-15 mS 24 hours after slaughter ,whereas in the DFD muscle electrical conductivity 24 hours after the slaughter was <4.3 mS.

The data obtained showed that according to electrical conductivity of *m. longissimus dorsi* 24 hours after the slaughter 10 percent of pig meat had the DFD defect whereas according to electrical conductivity of *m. semimembranosus* the DFD defect of meat was observed in additional 4 percent of pigs. Among the investigated pigs, PSE defect of meat was not found. Apparently this can be explained by the fact that Lithuanian white pigs are characterized by moderate muscle development and by the fact that the examined pigs were taken from small farms. Our data on the changes in muscle electrical of conductivity coincide with Sack and Höret (1989, 2003) data, which indicate that just two hours after slaughter the meat electrical conductivity begins to significantly change and the speed of this change depends on the quality of meat. Schmitten, et al. (2007) reported that a high quality meat fermentation processes take place more slowly than lower-quality meat. In the meat processing industry (when grading carcasses), it is important to quickly and accurately identify defects in meat. Applying meat electrical conductivity test for this purpose, it is important to know how the electrical conductivity of meat at different time spans after laughter correlates with matured meat quality traits.

The data on the correlation of electrical conductivity and meat quality parameters are presented in Table 2.

Table 2. **The correlation coefficients between the** *m. longissimus dorsi* **electrical conductivity and quality indicators,** r

Indicators	Time after the slaughter, min.					Time after the slaughter, h	
	45	60	90	120	150	24	48
pH	0.56	0.46	0.30	0.34	0.31	-0.01	0.07
Shear force, kg/cm^2	0.49	0.34	0.17	0.12	0.13	-0.34	0.06
Cooking loss, %.	-0.18	-0.25	-0.36	-0.15	-0.18	-0.29	0.10
Water binding capacity, %	0.61	0.50	0.22	0.12	0.06	0.28	0.26
Color, EK	0.14	0.13	0.17	0.22	0.20	-0.19	0.12
Fat, %	-0.15	-0.20	0.03	0.21	0.32	-0.01	-0.14
Dry matter, %	-0.01	-0.08	0.05	0.10	0.11	-0.13	-0.06

The data given in Table 2 show that correlation coefficients between some of the meat quality parameters investigated 48 hours after slaughter and electrical conductivity during the first 45 minutes after the slaughter are quite high and have practical significance. Mature meat water binding capacity, pH and hardness are in best correlation with electrical conductivity during the first 45 minutes after animal's slaughter. The correlation coefficients between other meat quality parameters and electrical conductivity 45 minutes after slaughter are not significant. With increasing time after slaughter and maturity of meat, the correlation coefficients between electrical conductivity and matured meat quality indicators are low. It can be pointed out, that electrical conductivity of meat may be used for grading pig carcass only in the first 45–60 minutes ($p < 0.001$) after slaugther. Subsequently, the accuracy decreases, although the trend continues. Our data about electrical conductivity of meat during the first hour and its relationship with hardness coincides with Lepetit et al. (2001) data, who have found, that the correlation coefficient between electrical conductivity of meat and hardness is r = 0.56. Demo et al, (1993) have found an even higher correlation coefficient between the electrical conductivity of pork and meat water binding capacity 45 minutes after slaughtering. It was r = 0.72. The fact that within the first 50 minutes after slaughter there is a close link between electric conductivity of meat and matured meat pH, meat water binding capacity and other factors has been established by R. Stupka et al (1993).

Conclusions:

1. With increasing time after slaughter, electrical conductivity in muscle increases, but the correlation coefficients between electrical conductivity and some meat quality traits decreases.
2. Determining electrical conductivity in muscle during the first 45–50 minutes after slaughter can be used as a method of differentiating pig carcasses with PSE and DFD defects.

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