TYPICALLY DEFINABLE RESPIRATORY LESIONS AND THEIR INFLUENCE ON MEAT CHARACTERISTICS IN PIGS

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Summary. Lung pathologies are considered to be of great economic importance, as they affect the productivity of pigs and also are a problem in meat inspection. The aim of this study was to determine the most frequent respiratory pathologies in pigs at Lithuanian slaughterhouses and to estimate their influence on the physical-chemical characteristics of *musculus longissimus dorsi*.

Lesions of pneumonia, mainly typical "enzootic pneumonia" were detected in 46.14 % of all investigated lung samples. Pleuritis, alone or associated with pneumonia was recorded in 29.55 % of all examined cases. Variable numbers of abscesses, necrosis, and inflammation focuses in lungs of slaughtered pigs were observed, but the lungs were not significantly affected by pneumonia. In pigs with pneumonia statistically significant. Furthermore, in pigs with pathological lesions in the lungs significant increament of meat pH ($p<0.05$) and tenderness ($p<0.01$) compared to normal pigs was registered. However, meat yellowness b^* was significantly higher ($p<0.05$) in the group of normal pigs.

Key words: post-mortem examination, offal, lung pathology, meat quality, physical-chemical characteristics.

SKERDYKLOSE DAŽNIAUSIAI NUSTATOMI KIAULIŲ RESPIRATORINIAI POKYČIAI IR JŲ ĮTAKA MĖSOS KOKYBEI

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Santrauka. Atlikus kiaulių poskerdiminę ekspertizę, daugiausia patologinių pokyčių rasta plaučiuose. Plaučių susirgimai turi įtakos sveikatingumui, kiaulių augimui. Dėl plaučių ligų patiriami dideli ekonominiai nuostoliai. Mūsų tyrimo tikslas buvo Lietuvos skerdyklose nustatyti kiaulių respiratorinių susirgimų dažnumą ir įvertinti jų įtaką mėsos fiziniams bei cheminiams rodikliams.

Plaučių uždegimas, daugiausia enzootinei mikoplazminei pneumonijai būdingi pokyčiai, nustatytas 46,14 proc. paskerstų kiaulių; pleuritas diagnozuotas 29,55 proc. kiaulių; abscesai ir nekrozės židiniai sudarė nedidelę dalį poskerdiminės ekspertizės metu nustatytų plaučių patologijų. Tyrimų duomenimis, mėsos pH ($p<0,05$) ir kietumo ($p<0,01$) rodikliai buvo didesni tų kiaulių, kurių plaučiuose rasti patologiniai anatominiai pokyčiai, tuo tarpu mėsos gelsvumo rodiklis buvo didesnis sveikų kiaulių.

Raktažodžiai: poskerdiminė ekspertizė, plaučių patologija, mėsos kokybė, fizikinės ir cheminės savybės.

Introduction. Possible risks due to unsafe meat obtained from pig carcasses at slaughterhouses are eliminated by the strict veterinary inspection of animals prior to slaughter, as well as of meat and organs after slaughter. A specification of slaughterhouse findings and expression of trends in different areas may indicate increased risks with regard to certain aspects of food-borne diseases originating from meat and organs of slaughter pigs (Kozak et al., 2002). Several authors have studied animal health status on the basis of findings at slaughterhouses and emphasized that one of the main pathological findings of pigs by examination of the carcass at the abattoir is respiratory diseases, which are considered to be of great economic importance, as they affect the productivity of pigs.

Osborne et al. (1981) analyzed the findings of a total of 15,409 set of lungs and evaluated that 60.5 % were judged to be normal, 36.7 % had lesions of pneumonia involving the cranioventral areas in grey or red colored consolidation and 2.1 % had lesions of pleuritis unassoci-

ated with pneumonia.

Schuh et al. (2000) studied the findings in slaughtered pigs and also the relation between the occurrence of findings and the economic effects to slaughtered pigs in Austria. The authors observed the following results: pneumonia was found in 83.3 %, pleuritis in 26.3 %, pericarditis in 2.6 %, and milk spots in liver in 47.5 % of the slaughtered pigs.

During the emergency slaughter of pigs, the amount of respiratory diseases was high, showing 21.21 % positive cases (Kozak et al., 2004).

Wilson et al. (1986) investigated the association between pathological respiratory conditions and growth rates in 27 Ontario herds. Pneumonia was found in 79.3 %, pleuropneumonia in 9.4 %, and localized and diffuse pleuritis in 12.1 % of the 1,534 cases of slaughtered pigs.

The results from the post-mortem examination in growing-fattening pigs performed by Hannson et al. (2000) have shown a significance difference between swine from organic systems and pigs reared in conventional rearing systems. The most common pathological finding in conventionally reared swine was pleuritis, which was found in 7.4 % of all reared pigs slaughtered conventionally.

According to Minkus et al. (2004), the maturation of pork meat is clearly drawn in the direction of DFD by profound lung alteration. 91.4 % of the carcasses without lung disorder showed no alteration of meat quality. 6.8 % showed a pH change in terms of PSE, and 1.8 % in terms of DFD. Of those pigs with profoundly anatomically modified lungs, 11.9 % showed no alteration of meat quality. 1.1 % showed a pH change in terms of PSE, and 87 % in terms of DFD.

Animal health is the parameter which is most important for the classification of meat (Kozak et al., 2002), as well as for meat quality parameters with regard to their capability to serve for human consumption. Much of the investigation data indicates that meat is affected by various factors, such as age and sex (Virgili et al., 2003), genetic factors (Adegoke and Falade, 2005), diet (Apple et al., 2003), nutritional supplementation (Schaefer et al., 2001), environmental enrichment (Klont et al., 2001; Liorančas et al., 2006), preslaughter conditions (Hambrecht et al., 2004) and processing variables as well. On the other hand, several studies emphasized that respiratory pathology is one of the main pathological findings of pigs in carcass examinations after slaughter. However, little is known regarding how it affects meat quality characteristics.

The aim of this study was to determine the most frequent respiratory pathologies in pigs and to estimate their influence on the physical-chemical characteristics of meat.

Materials and Methods. Post-mortem examination for morbidity evaluation of 1,905 slaughtered pigs at a small Lithuanian abattoir was made from January to April of 2007. The offal of slaughtered pigs was examined after removal from the carcass, and macroscopically visible lesions were recorded for the lungs, heart and liver. Investigation for the evaluation of their influence on the physical-chemical characteristics of the meat included in total 21 Landrace and Large White crossbreds (females and males castrates) of 6 months of age from the commercial pig farm. The environmental and housing conditions of this farm were poor – the insulated and ventilated facilities were inadequate, there were open spaces in the pen dividers, and the growing-finishing rooms were crowded (>200–300 pigs). Pigs were slaughtered in the same slaughterhouse. Therefore, feeding, transportation to slaughterhouse, factors and handling before slaughter and the slaughtering process were identical for all the pigs examined. According to the technique suggested by Blaha (1994), the detected lung lesion data was sorted into three groups as follows: lungs without pathological findings (I group), lungs with pneumonia of a middle degree (11–30 % of affection) together with pleuritis (II group) and lungs with pneumonia of a high degree (over 30 % of affection) together with pleuritis, which affected a considerable area of the lungs (III group). Other attendant pathological findings were excluded from the trial, therefore the meat for investigation was only from pigs which had lung lesions of varying degree. After post-mortem examination, 21 meat samples (550 g) from each named group for meat quality evaluation were taken from the *musculus longissimus dorsi* removed from the left side of the carcasses at the level of the last ribs, and refrigerating over a 24 hour period in a chiller at +4^{o}C. The meat quality analysis was made at the Laboratory of Meat Characteristics and Quality Assessment at the Lithuanian Veterinary Academy. The dry weight of the meat was determined with automatic dry weight scales after drying the samples at a temperature of 105^{o}C, and the meat pH by ISO 2917:1999, Meat and meat products. The Measurement of pH Reference method; meat color according to the CIE-LAB method with a Minolta Chroma Meter measuring the lightness (L*), redness (a*) and yellowness (b*); ash by burning the organic material of the meat at a temperature of 600–800^{o}C, according to ISO 936:1998, Meat and meat products, Determination of total ash. Other meat parameters were examined as follows: drip loss by the decrease in weight of the meat sample during 36 hours after keeping the samples in special reticulate bags at a temperature of +4^{o}C; water holding capacity by the method of Grau and Hamm; cooking losses of the meat by cooking the meat in a circulating bath at 70^{o}C according to the change in weight of the meat samples before and after cooking; meat tenderness according to the Warner Bratzler test.

Statistical analysis was performed with the ANOVA procedure in SPSS 13.0 for Windows. The model included respiratory lesions. A second model included the different respiratory pathological findings. Differences in the meat quality parameters across the investigated groups were tested using the Fisher's protected least significant difference test. Pearson's and Spearmen's correlation coefficients were calculated for all groups.

Results and discussion. The most definable pathological findings during post-mortem examination were evaluated in the lungs of the slaughtered pigs. The incidence of post-mortem abnormalities registered during the post-mortem examination of the pigs is presented in Table

1. A considerable amount of the pathological findings of the lungs were found to be concerned with the technological slaughtering process (haemorrhage associated with electrical stunning and water or blood aspiration in a scalding tank), and that amounted averaged 40.42 %. For that reason, the lungs of these slaughtered pigs are judged as not edible for human consumption. Lesions of pneumonia, mainly typical "enzootic pneumonia", were detected in 46.14 % of the lungs from 1,905 slaughtered pigs. Lesions were most common in the cranioventral lobes of the lungs with red or grey consolidation. Pleuritis, alone or associated with pneumonia was evaluated in 29.55 % of all the examined cases. Evidence of abscesses or necrosis in the lungs was also noted. However, these findings were recorded as a small part of all detected pathological findings.

The frequency of pericardium lesions was evaluated as 3.52 % of all the examined offal of the pigs.

The differences between the meat quality parameters of the examined groups were described in Table 2. The amount of dry matter of the meat from I group (control group) was 1.81 % less than the meat from II group and 1.1 % less than the meat from III group. However, the differences in this parameter in the experimental groups were not statistically significant, whereas the pH of the meat between the investigated groups was statistically significant. The lowest pH was estimated in the I group, and the II group had a significant difference of 0.08 ($p<0.05$) from it, while the III group had a significant difference of 0.07 ($p<0.05$).

The color intensity of the meat of pigs which had clear respiratory lesions after post-mortem examination (II, III group) was lower than those which had any pathological findings. The color intensity of the II group was different from the I group by 0.38 % and from the III group by 1.83 %. Furthermore, the yellowness b^* of the meat was more intensive in the meat from the pigs which had no respiratory lesions ($p<0.05$).

Our results show that the respiratory lesions of pigs influenced meat tenderness as well. Meat of pigs with lung pathologies was tenderer and had significant differences from the groups examined ($p<0.01$). The drip loss and water holding capacity of the meat of healthy pigs were higher compared to the pigs which had respiratory lesions. However, these parameters were not statistically significant.

On the basis of our study, we can suggest that the respiratory lesions of pigs affect meat pH, color intensity and tenderness similarly (Table 3). Our investigation results show that the meat tenderness ($p<0.01$) in pigs with pneumonia is higher than in healthy pigs. The same tendency is shown in pleuritis cases ($p<0.01$). The presence of lesions in lungs during the slaughter process can vary meat tenderness as well as influencing variations in water holding capacity ($p<0.01$). Studies of mycoplasmal pneumonia and the effects of vaccination against *Mycoplasma hyopneumoniae* on chemical and physical properties of *musculus longissimus dorsi* showed that meat lightness L^*, drip loss and intramuscular fat were significantly higher than in the unvaccinated pigs (Šiugždaitė et al., 2006). According to our results, typical "enzootic pneumonia" lesions only influence meat color intensity b^* ($p<0.01$) (Table 3).

The lungs of pigs are provided for human consumption by many abattoirs, and the lungs of pigs not only indicate the healthy condition of pigs, but amount for a portion of the surplus value of production as well. Respiratory lesions are very important for the evaluation of economic losses, particularly those due to enzootic pneumonia (Šiugždaitė et al., 2006). Our study results for the morbidity evaluation of respiratory lesions align with many other authors' data that emphasize lung pathologies as one of most definable findings during post-mortem examination (Hanson et al., 2000; Osborne et al., 1981; Wilson et al., 1986).

It is generally accepted that carcasses with profoundly altered lungs vary in meat quality according to the pH value measured one hour and 24 hours after slaughtering (Minkus et al., 2004). The pH values of the *musculus longissimus dorsi* of all the pig groups investigated at 24 hours after slaughter are described in Table 2. Our investigation results are very close to those by Minkus (2004) et al. It is clear that the lowest pH value of meat is from carcasses with no lung alterations and that depending on the rate of lung pathology, pH value increases.

There is little information currently available on how respiratory lesions affect meat quality. However, meat quality parameters and their influencing factors are investigated often.

The influence of respiratory lesions on meat quality characteristics was evaluated 24 hours after slaughter. Many of the meat quality parameters examined were not statistically significant in the experimental groups, except meat yellowness, which was less ($p<0.05$) in respiratory lesion cases. Meat tenderness ($p<0.01$) and pH were higher ($p<0.05$) in respiratory lesion cases.

Table 1. **Lesions of conventionally reared pigs slaughtered at Lithuanian abattoir at 2007**

Pathological findings	Frequency	%
Pneumonia	121	6.35
Pleuritis	563	29.55
Pericarditis	67	3.52
Necrotic focal in lungs	35	1.84
Typical "enzootic pneumonia" lesions	879	46.14
Lesions in lungs during slaughter process	770	40.42

We consider that the alterations in quality indicators were caused by the health condition of pigs – in case of disease, pigs needed higher amount of energy therefore lower glycogen and adenosintriphosphate quantities after slaughtering resulted in the formation of lactic acid and, consequently, higher pH value of meat.

Table 2. **Mean and SE of meat quality characteristics**

Parameter		I group (n=7)	II group (n=7)	III group (n=7)
Dry matter, %		28.79 ± 0.88	30.60 ± 1.37	29.89 ± 0.63
pH		5.42 ± 0.02$^{*II;III}$	5.50 ± 0.02	5.51 ± 0.03
Color	L^*	55.88 ± 0.95	55.50 ± 1.42	54.83 ± 0.93
	a^*	15.12 ± 0.58	14.92 ± 0.60	15.34 ± 0.35
	b^*	7.92 ± 0.64^{*II}	6.36 ± 0.42^{*III}	6.99 ± 0.54
Drip loss, %		6.66 ± 0.77	5.53 ± 0.58	5.12 ± 0.97
Water holding capacity, %		55.45 ± 0.77	54.35 ± 1.46	53.55 ± 1.12
Cooking loss, %		27.89 ± 0.79	24.79 ± 2.21	28.93 ± 0.81
Tenderness, kg/cm^2		0.88 ± 0.05^{**III}	1.18 ± 0.19	1.46 ± 0.12
Proteins, %		22.38 ± 0.47	22.51 ± 0.37	21.88 ± 0.22
Intramuscular fat, %		2.55 ± 0.16	2.78 ± 0.31	2.57 ± 0.20
Ash, %		1.15 ± 0.01	1.13 ± 0.01	1.16 ± 0.01

Note. * p<0.05; ** p<0.01.

Table 3. **Differences between respiratory pathological findings and meat quality characteristics**

Pathological findings		n	Dry matter, %	pH	Color (b^*)	Water holding capacity, %	Tenderness kg/cm^2
Pneumonia	-	13	29.91±0.83	5.46±0.02	7.14±0.46	54.90±0.85	1.03±0.11*
	+	8	29.52±0.67	5.49±0.03	7.02±0.46	53.73±0.98	1.14±0.11
Pleuritis	-	9	29.17±0.95	5.45±0.02	7.62±0.54	55.12±0.65	0.96±0.08*
	+	12	30.21±0.70	5.50±0.02	6.70±0.38	53.95±1.01	1.33±0.13
Typical "enzootic pneumonia" lesions	-	14	29.74±0.64	5.46±0.02	7.56±0.40*	54.18±0.64	1.04±0.09
	+	7	29.82±1.21	5.50±0.03	6.16±0.37	54.99±1.52	1.44±0.18
Lesions in lungs during slaughter process	-	10	30.98±0.80*	5.50±0.02	6.74±0.44	53.07±1.02*	1.39±0.14*
	+	11	28.66±0.65	5.45±0.02	7.42±0.47	55.71±0.60	0.98±0.09
Lesions in pleura of carcass	-	7	28.88±0.88	5.43±0.02*	7.92±0.65	55.45±0.78	0.88±0.05*
	+	14	30.25±0.71	5.50±0.02	6.68±0.33	53.95±0.86	1.32±0.11

Note. – No pathological findings; + pathological findings; * p<0.01

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