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INFLUENCE OF PH_1 OF FATTENERS' *MUSCULUS LONGISSIMUS LUMBORUM* ON THE CHANGES OF ITS QUALITY*

Mariusz Florek, Anna Litwińczuk, Piotr Skałecki, Barbara Topyła

Department of Animal Raw Material Estimation and Utilization, Agricultural University, Lublin

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Depending on initial pH, the physicochemical properties of fatteners' *musculus longissimus lumborum* (electric conductivity, colour – CIE Lab values, cooking and drip loss as well as the crude protein content) were investigated, distinguishing 3 groups, *i.e.* I – to 5.8 (n=16), II – from 5.8 to 6.3 (n=28), and III – over 6.3 (n=20). The range of the initial pH had no significant influence on the physicochemical properties of pork *musculus longissimus lumborum*, with the exception of electrical conductivity 45 min *post mortem* as well as lightness. On the basis on established critical values for the pork quality standards, the results indicate that meat with $pH_1>6.3$ (group III) met requirements for normal meat, meat with $pH_1 <5.8$ (group I) – for PSE, and meat with pH_1 5.8–6.3 (group II) – for RSE defect. Significant and negative correlations were found between the pH_1 value and the electric conductivity value 45 min and 24 h *post mortem* (r=-0.488 and r=-0.326, respectively), lightness L* (r=-0.562) as well as drip loss (r=-0.494) and b* value (r=-0.376).

INTRODUCTION

Desirable normal pork binds water well, has a red colour and its substance is firm. These 3 most important traits of meat quality determine its culinary and processing value and can be characterized by means of a number of methods. The oldest ones which have been used up till now are related to pH measurements. Kortz *et al.* [1968] developed the first classification of the Polish origin in 1968. It referred to meat classification based on pH measurement 45 min after slaughter and made it possible to differentiate normal meat from PSE and partly watery. Other defects, like acid meat or RSE, were unknown. Therefore, the basic criterion for the quality classification of pork, used in research and increasingly in meat plants, is the measure of its reaction. This evaluation is usually based on the acidity of the *musculus longissimus*. There are certain discrepancies as far as the pH_1 value for watery meat with a low technological value is concerned (PSE meat).

Kortz [1970] claims that normal meat should demonstrate pH values higher than 6.3, partly exudative meat - from 6.0 to 6.3, and exudative meat – below 6.0. Honikel and Fischer [1977] determined pH value for PSE meat also below 6.0 without distinguishing partly exudative meat. They suggested the limit value of $pH_1 \geq 6.0$. Other authors [Bendall & Swatland, 1988; Eikelenboom, 1990] indicate the appearance of PSE meat at pH_1 values ≤5.8.

The aim of this survey was to evaluate the physicochemical properties of meat from the longest dorsal muscle depending on its initial pH.

MATERIALS AND METHODS

The research included 64 fatteners from mass rearing in the region of Central-East Poland. Slaughter complied with the technology applied in the meat industry.

A PQM I-KOMBI apparatus of the Intek company (Germany) was used to mark two parameters: pH reaction and electric conductivity EC (mS/cm); measurements were taken 3 times: 45 min (pH_1 and EC_1, respectively), 24 h (pH_{24} and EC_{24}), and 48 h *post mortem* (pH_{48} and EC_{48}). Samples of the longest dorsal muscle were taken during the cutting to identify the physical properties of meat. Water binding capacity was measured 48 h *post mortem* including the drip and cooking loss [Wajda, 1986] as well as the crude protein content by the Kjeldahl's method using a Büchi–B324 equipment.

Meat colour, after a 30-min exposure, was evaluated by means of a colour saturation chromameter Minolta CR-310. The measure head used the wide-angle illumination (broad image), geometry 0° projection angle and 50 mm measurement area. The sample results were worked out as the arithmetical means from two measurements. The absolute results were given as trichromatic values in the colour space L*a*b* [CIE, 1976], where: L* – metric lightness, a* – red colour, b* – yellow colour. The meter was calibrated on a white model plate CR-A44 with the calibration data Y=93.50, x=0.3114, and y=0.3190.

The statistical analysis was carried out with a one-way variance analysis, distinguishing 3 groups with regard to pH_1 value, *i.e.* I – to 5.8 (n=16), II – from 5.8 to 6.3 (n=28),

Author's address for correspondence: Mariusz Florek, Katedra Oceny i Wykorzystania Surowców Zwierzęcych, Akademia Rolnicza, ul. Akademicka 13, 20-950 Lublin, tel.: (48 81) 445 66 21; e-mail: florek@ursus.ar.lublin.pl

and III – over 6.3 (n=20). The significance of differences between means in individual groups was verified using the Duncan's test. The simple correlation coefficient between the pH_1 value and the remaining parameters was also evaluated.

RESULTS AND DISCUSSION

The pH value is the first easily-recognisable trait of the defect symptoms in meat. Depending on the rate of the occurring processes of decreasing or maintaining the pH value in muscles after slaughter, different quality classes of pork are identified. In the case of the animals prone to PSE, the rate of glycolysis after slaughter and pH drop caused by the accumulation of milk acid are the reason of the changes in proteins and the muscle tissue structure. This reduces water-binding capacity and, thus, worsens the sensory qualities of meat and limits its processing suitability [Anonim, 1997].

The average initial meat acidity in groups amounted to: group I – 5.67, II – 6.06 and III – 6.55, respectively (Table 1). Meat pH 24 h *post mortem* in all the groups did not differ significantly and ranged between 5.52 and 5.62. After 48 h, meat qualified to the groups I and II had significantly the lowest pH value (5.49 and 5.51) compared with the group III (5.68).

TABLE 1. Physicochemical properties of the *musculus longissimus lumborum* depending on initial pH ranges.

Specification		pH <5.8	pH 5.8–6.3	pH >6.3	Corr. coef. with pH_1
pH_1	$\bar{x}$	5.67^A	6.06^B	6.55^C	–
	s	0.16	0.15	0.18	
pH_2	$\bar{x}$	5.52	5.55	5.62	0.182
	s	0.19	0.15	0.12	
pH_3	$\bar{x}$	5.49^A	5.51^A	5.68^B	0.043
	s	0.21	0.18	0.08	
EC_1 (mS/cm)	$\bar{x}$	5.83^B	4.13^A	3.69^A	-0.488***
	s	2.28	1.26	0.55	
EC_2 (mS/cm)	$\bar{x}$	13.77	14.59	12.73	-0.326***
	s	2.18	4.09	4.20	
EC_3 (mS/cm)	$\bar{x}$	14.15	14.27	15.41	-0.146
	s	1.43	2.23	1.76	
CIE					
L*	$\bar{x}$	54.50^b	53.47^{ab}	51.71^a	-0.562***
	s	3.20	2.59	2.47	
a*	$\bar{x}$	16.27	16.22	15.67	-0.147
	s	1.56	0.90	0.90	
b*	$\bar{x}$	5.74	5.59	4.91	-0.376**
	s	1.00	1.61	1.10	

Means in rows marked with different letters differ significantly: a, b – at $p\leq0.05$, A,B – at $p\leq0.01$.
* – at $p\leq0.05$, ** – at $p\leq0.01$, *** – at $p\leq0.001$.

Due to a number of reasons causing the occurrence of meat defects, it is necessary to evaluate additional parameters which characterise the quality of muscle tissue, namely electric conductivity, colour or water binding.

The measurement of electric conductivity (EC) is the measure of infrangibility of cellular membranes in the muscle tissue [Honikel, 1993], which retain liquids within and outside cells. Muscle tissue with intact cellular membranes has a low EC value, which grows together with an increase in the water content inside the muscle.

The average value of electric conductivity measured after 45 min differed significantly between the groups reaching 5.83 in group I, 4.13 in group II, and 3.69 mS/cm in group III. No significant differences between the groups were found 24 and 48 h *post mortem* with regard to electric conductivity. It should be mentioned that the EC 24 h *post mortem* had high average values in all the groups ranging from 12.73 (group III) to 14.59 mS/cm (group I).

Some authors [Borzuta *et al.*, 2002; Borzuta & Pospiech, 1999] suggest a simplified way of distinguishing PSE and ASE meat based on the pH_1 measurement approx. 45 min (≤5.8 – PSE; >6.3 – ASE) after stunning, and electric conductivity of the longest dorsal muscle 24 h after slaughter. Carcasses whose EC value amounts to 10 mS or more should be treated as raw material with quality deviation of the PSE and ASE type.

The evaluation of colour indicated that meat of group I had the significantly lightest colour which is proved by the L* value reaching 54.5 in comparison with group II – 53.47 and III – 51.71. The highest (though insignificant) share of red – 16.27, and yellow – 5.74 colours was observed also in this group.

The analysis of the water holding capacity showed that the worst water binding was in group I (Table 2), which was proved by the highest drip loss (6.97%). No significant differences were however, observed between groups. It is worth noticing that meat in this group had the highest protein content which amounted to 25.63% compared with group II – 25.26% and III – 24.00%.

TABLE 2. Water holding capacity parameters and crude protein content in the *musculus longissimus lumborum* depending on initial pH ranges.

Items		pH <5.8	pH 5.8–6.3	pH >6.3	Corr. coef. with pH_1
Drip loss (%)	$\bar{x}$	6.97	5.41	4.45	-0.494**
	s	0.30	2.37	2.16	
Cooking loss (%)	$\bar{x}$	25.72	26.19	27.31	0.317*
	s	3.02	4.58	4.66	
Crude protein (%)	$\bar{x}$	25.63	25.26	24.00	-0.035
	s	3.52	2.32	2.47	

* – at $p\leq0.05$, ** – at $p\leq0.01$, *** – at $p\leq0.001$.

The assessment of the simple correlation rates proved a highly significant but negative dependence ($p\leq0.001$) between the pH_1 value and the electric conductivity value 45 min and 24 h *post mortem* (r=-0.488 and r=-0.326) and lightness L* (r=-0.562). For the b* value, the best correlation of coefficient was identified at r=-0.367.

Schmitten *et al.* [1984] identified higher correlation rates for the pH measurement taken 40-50 min *post mortem* and for electric conductivity (r=-0.51). According to Sack and Brancheid [1990] this value reached r=-0.58, whereas Sack *et al.* [1987] reported it to reach r=-0.67 and Van Laack and Kauffman [1999] – to r=-0.71. Van Oeckel *et al.* [1999b] quoted lower correlation values concerning the lightness and b* value, namely r=-0.53 for L* and r=-0.26 for b*.

This research indicated also significant negative dependencies ($p\leq0.01$) for the pH_1 and drip loss (r=-0.494).

According to Jauda *et al.* [1992], the usability of pH measurements or electric conductivity for the evaluation of other meat quality traits, especially water binding, results from the damage of cellular membranes during a violent *post mortem* glycolysis and releasing intracellular fluids. Van Laack and Kauffman [1999] established the correlation rate between pH and drip loss as r=-0.73 and Van Oeckel *et al.* [1999a] as r=-0.34.

According to Pospiech [2000], the measurements of pH value or other meat properties, which are usually carried out in the longest dorsal muscle behind the last rib, are acceptable to monitor the quality of meat in carcasses. It should be noted, though, that the intensification of a defect is not necessarily equal for the whole carcass. Moreover, particular parts of carcasses tend to have different acidification.

Van Oeckel *et al.* [1999b] stated that on-line techniques used *post mortem* are not appropriate for the prediction of the final meat quality of individual carcasses, although they can be useful for the determination of the case of PSE meat in animal groups. Therefore, they can constitute a source of information for producers and serve as a tool to distinguish the normal meat.

CONCLUSIONS

1. The range of initial pH had no significant influence on the physicochemical properties of pork *musculus longissimus lumborum*, with the exception of electrical conductivity 45 min *post mortem* as well as lightness.

2. On the basis of the established critical values for the pork quality standards the results indicate that meat with $pH_1>6.3$ (group III) met the requirements for normal meat, meat with $pH_1<5.8$ (group I) – for PSE, and that with pH_1 5.8–6.3 (group II) – for RSE defect.

3. Significant and negative correlations were found between the pH_1 value and the electric conductivity value 45 min and 24 h *post mortem*, lightness L* as well as drip loss and b* value.

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WPŁYW PH_1 MIĘŚNIA *LONGISSIMUS LUMBORUM* TUCZNIKÓW NA PRZEBIEG ZMIAN JEGO JAKOŚCI

Mariusz Florek, Anna Litwińczuk, Piotr Skałecki, Barbara Topyła

Katedra Oceny i Wykorzystania Surowców Zwierzęcych, Akademia Rolnicza, Lublin

Celem pracy była ocena kształtowania się właściwości fizykochemicznych mięsa pochodzącego z mięśnia najdłuższego grzbietu tuczników w zależności od jego pH początkowego, z wyróżnieniem trzech grup tj. I – do 5,8 (n=16); II – od 5,8 do 6,3 (n=28) i III – powyżej 6,3 (n=20). Za pomocą aparatu PQM I-KOMBI firmy INTEK GmbH, trzykrotnie tj. po upływie 45 minut oraz 24 i 48 godzin od uboju, oznaczano pH i przewodność elektryczną właściwą. Po 48 godz. *post mortem* oznaczono wyciek naturalny i termiczny, jak również zawartość białka ogólnego metodą Kjeldahla. Barwę mięsa (L*a*b*) po 30 minutowej ekspozycji, oceniano za pomocą miernika nasycenia barwy Minolta CR-310. Nie stwierdzono istotnego wpływu pH początkowego mięśnia najdłuższego lędźwi na właściwości fizykochemiczne, za wyjątkiem przewodności elektrycznej 45 minut *post mortem* i jasności) (tab. 1 i 2). W oparciu o wartości krytyczne przyjęte dla wieprzowiny, mięso o $pH_1 > 6,3$ (grupa III) spełniało wymagania dla mięsa normalnego, o $pH_1 < 5,8$ (grupa I) dla wady PSE, natomiast mięso o pH_1 5,8–6,3 (grupa II) spełniało kryteria dla wady RSE.

Oceniając współczynniki korelacji prostej stwierdzono wysoko istotny i ujemny związek ($p \leq 0,001$) pomiędzy wartością pH_1 a wartością przewodności elektrycznej po 45 minutach i 24 godz. od uboju oraz jasnością L*, jak również wyciekiem naturalnym i udziałem barwy żółtej b* (tab. 1 i 2).