51st International Congress of Meat Science and Technology
August 7-12, 2005 – Baltimore, Maryland USA

DISTRIBUTION OF PSE MEAT IN SKELETAL MUSCLES OF PIG CARCASS

Strzelecki J., Borzuta K., Tyszkiewicz S.*

Meat and Fat Research Institute, ul. Jubilerska 4, Warsaw, Poland

Keywords: pig half-carcasses, PSE meat, distribution in muscles

Introduction

Quality defects in pig meat generate considerable economic losses in meat production. Pospiech and Borzuta (1998) estimated that annual losses caused by occurrence of PSE and acid meat amounts to about 2,4% of raw material value. There are about 100 striped muscles in a pig half-carcass, but only five of them compose 1/3rd of carcass muscle weight and they are the main part of two most important cuts, i.e. loin and leg.

Quality defects in meat are developed in the most valuable muscle groups with a considerable percentage of pale fibers and sometimes only in a part of an examined muscle (Linke and Heinz 1972, Koćwin-Podsiadła *et al*. 1998, Kauffman *et al*. 1993, Borzuta *et al*. 2001). Present research concerns mainly the *longissimus dorsi* muscle and there is lack of thorough data concerning PSE meat distribution in other carcass muscles.

Objectives

The objective of the study is to define of the anatomic-spatial distribution of PSE meat in skeletal muscles of pig carcass depending on the rate of meat acidification after slaughter.

Methodology

Research material comprised of 80 pig carcasses chosen on the basis of pH_1 measurement in *longissimus lumborum (LL)* muscle, what took place on slaughter line in a slaughter house situated near Poznań. Carcasses were divided into following 4 groups, 20 half-carcasses each, depending on quality, differing as for pH_1 level in LL muscle, measured at first lumbar vertebrae about 45 min. after slaughter: group A – $pH_1 \leq 5,8$, group B – pH_1 5,81 – 6,00, group C – pH_1 6,01 – 6,30, control group D – $pH_1 > 6,30$ and $pH_{24} < 6,2$. Quality groups were chosen on the basis of results of research conducted by many authors who studied PSE meat (Briskey 1964, Kortz 2003, Krzywicki 1972, Kauffman *et al*. 1993, Pospiech and Borzuta 1998).

pH value of meat was measured using the Radiometer PHM 80 Portable pH-meter equipped in a combined electrode. pH measurements were conducted on hanged left carcasses in the following muscles: *longissimus dorsi* in 3 points (near neck part, back part and near leg part), *triceps brachii, semimebranosus, biceps femoris, quadriceps femoris, and gluteus medius*.

In the above mentioned muscles, electrical conductivity was also measured, 3h (EC_3) and 24h (EC24) after slaughter using PQM Combi device, as well as lightness, 24 h after slaughter (Minolta Chroma Metters CR-300). Chilled half-carcasses were cuted into joints and then the joints were de-boned.

Pale meat with PSE symptoms was cut out of the de-boned joint meat and weighed with accuracy to 5g. The pale meat suitable for cutting was examined by a team of 3 experts from Meat and Fat Research Institute, with the help of color quality standard included in annex 1 of Agriculture Canada Publication 5180/B. For the purpose of statistic calculation, variance analysis as well as Tukey test (Statistica PL 1997) was used.

Results & Discussion

The muscles most compliant to quality changes of PSE type are those from most valuable half-carcass parts, i.e. loin and leg and, in smaller degree, shoulder and neck (tab. 1). Pale meat was not found in fat joints of half-carcass, such as: belly, jawl and ventral part of belly.

Analysis of data included in tab. 1 raises reflection that the percentage of PSE meat in particular joints as well as in all half-carcass decreases considerably in particular quality groups A to D. However, in first two groups the percentage is the highest and exceeds 10% of carcass weight. In group C of half-carcasses, classified as partly watery meat group, the percentage of pale meat with PSE symptoms is 2 to 3 times lower than in groups A and B. Occasional occurrence of pale meat in some carcass joints classified as normal quality meat group can be explained by natural lightness change caused by factors other than glycolysis, e.g. lower level of myoglobin (Krzywicki 1972).

High percentage of PSE meat in groups A and B undermines the legitimacy of pH_1 $\leq$5,8 limit as the indicator of watery meat and proves that more legitimate limit would be pH_1 $\leq$6,0. Such a limit was proposed in earlier research conducted by Bendall and Lawrie (1964), Krzywicki (1972) and Kortz (2003).

Average value of investigated muscle pH is distinctly and statisticall significantly diversified depending on quality group (tab. 2). The lower acidity is smaller the experimental group is doser to a control group. It means that pH_1 of all examined muscles increases from group A to D. Those results are connected with accepted concept of diversification of the research groups on the basis of pH_1 measurement in the middle part of *longissimus dorsi* muscle.

Within particular research groups the highest pH_1 values were observed in the muscles: *triceps brachii* and *quadriceps femoris.* Those differences are present also during the later period of after slaughter changes. Correlation between pH_1 of LD muscle and the results of other examined muscles is also an interesting issue. Correlation factors between pH_1 of LD muscle and pH_1 of other muscles were statistically significant (P $\leq$0,01) and amounted to: *biceps femoris* muscle 0,9976, *gluteus medius* muscle 0,9945, *semimembranosus* muscle 0,9833, *triceps brachii* muscle 0,9822, *quadriceps femoris* muscle 0,9723, *psoas major* muscle 0,9524. The defined correlations as well as the results of examination of other LD muscle quality traits, such as electrical conductivity and lightness, enabled the researchers to provide a linear regression equation (r^2 = 0,85) to estimate the percentage of pale meat with PSE traits in a carcass (Y), what is as follows:

$$Y = 234,4 – (5,21\ pH_1 + 9\ EC_3 – 6,96\ EC_{24} + 2,40\ L)$$

where:

EC_3 – electrical conductivity 3h after slaughter, EC_{24} – electrical conductivity 24h after slaughter,

L – lightness 24h after slaughter, %).

Conclusions

1) The percentage of pale meat with PSE symptoms, estimated in the thesis, in carcass groups with pH_1 of LD muscle ≤ 5,8 (A) and 5,81 – 6,00 (B) is very high as it constitutes 1/3rd of the meat obtained from carcass for group A and 1/5th for group B. As for half-carcass weight, the percentage of PSE meat amounts adequately to 17,51 and 10,34%.
2) Muscles most prone to PSE meat occurrence are loin and leg muscles, and, in smaller degree, shoulder, neck and shank. PSE meat was not found in belly, jawl and ventral part of belly.
3) Among factors predicting the percentage of PSE meat in pig carcass, measured instrumentally, the best are: pH_1, EC_3, EC_{24} and photometric lightness (L*) of *longissimus dorsi* muscle. Using those traits, a multiple regression equation was provided to estimate the percentage of PSE meat in carcass

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Tables and Figures

Table 1. Share of PSE meat in cuts and in the carcass (%)

Part of carcass	Quality groups			
	A	B	C	D
loin	48,37[a]	28,96[b]	23,54[c]	0,12[d]
leg with shank	37,49[a]	23,39[b]	8,71[c]	0,81[d]
shoulder with shank	9,28[a]	5,12[b]	0,46[c]	0,00[d]
neck	5,69[a]	3,52[b]	2,80[c]	0,00[d]
tenderloin	1,87[a]	1,01[b]	0,31[c]	0,00[d]
carcass	17,51[a]	10,34[b]	4,61[c]	0,21[d]

a,b,c,d – means with different indexes differ statistically significant ($P \leq 0{,}05$)

Table 2. Means of pH_1 of investigated muscle in different quality groups

Muscles	Trait	Groups			
		A	B	C	***D***
Longissimus dorsi (1)	$\bar{x}$ s	$5{,}62^{a}_{A}$ 0,07	$5{,}92^{b}_{A}$ 0,05	$6{,}18^{c}_{B}$ 0,05	$6{,}72^{d}_{C}$ 0,10
Longissimus dorsi (2)	$\bar{x}$ s	$5{,}73^{a}_{B}$ 0,17	$6{,}00^{b}_{B}$ 0,14	$6{,}25^{c}_{B}$ 0,12	$6{,}61^{d}_{B}$ 0,26
Longissimus dorsi (3)	$\bar{x}$ s	$5{,}74^{a}_{B}$ 0,15	$5{,}92^{b}_{A}$ 0,15	$6{,}26^{c}_{B}$ 0,14	$6{,}68^{d}_{B}$ 0,14
Psoas major	$\bar{x}$ s	$5{,}85^{a}_{B}$ 0,13	$6{,}02^{b}_{B}$ 0,17	$6{,}02^{b}_{A}$ 0,17	$6{,}48^{c}_{A}$ 0,13
Triceps brachii	$\bar{x}$ s	$5{,}99^{a}_{C}$ 0,16	$6{,}23^{b}_{C}$ 0,12	$6{,}32^{b}_{C}$ 0,14	$6{,}64^{c}_{B}$ 0,13
Biceps femoris	$\bar{x}$ s	$5{,}88^{a}_{B}$ 0,16	$6{,}09^{b}_{B}$ 0,07	$6{,}29^{c}_{B}$ 0,09	$6{,}70^{d}_{B}$ 0,14
Semimembranosus	$\bar{x}$ s	$5{,}76^{a}_{B}$ 0,10	$6{,}06^{b}_{B}$ 0,10	$6{,}25^{c}_{B}$ 0,11	$6{,}71^{d}_{B}$ 0,19
Quadriceps femoris	$\bar{x}$ s	$5{,}97^{a}_{C}$ 0,12	$6{,}29^{b}_{C}$ 0,10	$6{,}34^{b}_{C}$ 0,12	$6{,}69^{c}_{B}$ 0,17
Gluteus medius	$\bar{x}$ s	$5{,}85^{a}_{B}$ 0,10	$6{,}07^{b}_{B}$ 0,09	$6{,}30^{c}_{B}$ 0,14	$6{,}65^{d}_{B}$ 0,17

1 –last rib
2 – near neck
3 – near ham
a,b,c,d,e - statistically significant differences calculated for the investigated groups.
A,B,C - statistically significant differences calculated for the investigated muscles.