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Pork ham and belly quality can be estimated from loin quality measurements?

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ABSTRACT

The aim of the study was to determine the relationships between the quality evaluation of loin and the quality evaluation of ham and belly from the same carcasses for trying to predict the quality parameters of ham and belly based on measurements made on the loin. The research material consisted of 105 pork carcasses, from which three elements were cut and marked: loin, ham and belly. Quality evaluation included: pH, color, water holding capacity (WHC), cooking loss (CL), and sensory analysis. All designated quadratic equations were characterized by low R^2 values from 0.06 to 0.43 for ham and from 0.00 to 0.28 for belly. However, it is possible to predict the quality parameters of ham or belly with different levels of accuracy (R^2 from 0.50 to 0.92 - depending on the measurement and the element), using measurements selected from all those tested on the loin. Those loin quality measurements most frequently used in equations were chewiness and CL.

1. Introduction

Meat quality is one of the most important features for the modern pork consumer, which justifies the interest of slaughter and processing plants in the accurate evaluation of the main commercial cuts from pork carcasses. However, there is still a widespread (historically recorded) belief that the loin is the ideal element on the basis of which assumptions can be drawn about the quality of the pork carcass and all other elements (Boler et al., 2010; Huff-Lonergan et al., 2002; Van Oeckel & Warnants, 2003). The four reasons that support the use of the loin include: 1) the many strong relationships between the *Longissimus* muscle and the overall view of the pork carcass (Callow, 1948; Engel, Buist, Walstra, Olsen, & Daumas, 2003); 2) the fact that in the past the greatest contribution to the commercial value of the whole carcass stemmed from the loin; this is now clearly reorientated to ham and especially belly (Costa-E-Silva, Barbosa, Boler, & Silveira, 2017; Knecht & Duziński, 2016; Valous, Mendoza, Sun, & Allen, 2009); 3) the use of the loin as the main place for the estimation of lean meat content in semi-automatic devices for EU countries, expect for the ZP hand method (ham) and fully automated devices (all cuts) (Official Journal of the European Union, 2011); 4) the demonstration that loin measurements may be useful for prediction of the size of other elements and their commercial value (Knecht, Duziński, & Lisiak, 2016; Lisiak, Duziński, Janiszewski, Borzuta, & Knecht, 2015). Although these examples justify the important role of the loin in pork carcass, it seems too far-reaching to deduce the quality parameters of other elements on the basis of this single element alone.

Pork quality is a component of compositional, processing and consumption quality and is part of the set of all relevant characteristics of a product that determine its degree of perfection (FAO, 2014; Sienkiewicz & Lewandowska, 2012; Waylan, Unruh, & Johnson, 1998). Complications with pork quality characteristics are further deepened by the parameter of meat evaluation, which is a mixture of different chemical components determining quality independently or in combination with other ingredients (Válková, Salaková, Buchtová, & Tremlová, 2007). Moreover, each cut consists of different tissue composition, where the proportions of individual muscles, layers of fat and bones are different.

Unfortunately, taking into account the great variability of primal cut structures, still only a few studies deal with translation of loin quality parameters onto other elements. Definitely more scientific reports include, apart from the loin, other cuts especially ham, and less frequently belly during the verification of product quality. We are still not able to answer the question as to whether for a given mass population of slaughtered pigs conclusions can be drawn about the quality of other elements (especially ham and belly) only on the basis of the loin. We only know that there are some correlations between the loin quality parameters and quite different qualitative parameters of fresh or processed ham and belly (Arkfeld et al., 2016). However, there is still a lack of results referring to the same quality parameters and to the possibilities to estimate the quality parameters of fresh ham and belly on the basis of quality measurements of the loin.

Therefore, based on the above considerations the aim of the study

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Table 1
Characteristics of the study population.

Item	Loin				Ham				Belly			
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
Color (points)	3.23	0.42	2.60	3.90	–	–	–	–	–	–	–	–
Marbling (points)	2.56	0.47	1.40	3.40	–	–	–	–	–	–	–	–
pH	5.64	0.22	5.19	5.86	5.61	0.26	5.19	6.15	5.64	0.19	5.29	5.96
Instrumental color evaluation												
L*	57.15	4.10	51.61	64.31	47.86	2.96	42.29	52.86	53.32	2.58	50.12	58.56
a*	15.02	0.68	13.98	16.08	17.76	0.96	16.03	19.03	16.47	1.78	12.23	18.21
b*	6.99	1.21	5.25	8.73	6.71	1.76	3.69	9.92	6.96	1.16	5.29	9.83
C*	16.64	0.80	15.41	17.75	19.07	1.46	16.73	21.56	18.09	1.66	13.61	19.79
H*	24.86	3.85	17.98	29.51	20.27	4.06	11.84	26.79	22.86	4.41	17.55	36.25
WHC (%)	24.38	2.15	21.92	28.34	29.25	5.33	20.82	38.35	18.33	3.48	13.51	22.00
CL (%)	31.62	3.17	23.07	35.67	30.73	3.091	22.61	34.92	27.70	3.06	22.03	30.99
Sensory analysis (points)												
Taste	3.97	0.53	3.00	5.00	4.00	0.55	3.00	5.00	3.65	0.51	2.83	4.42
Flavor	4.11	0.26	3.40	4.40	4.02	0.51	3.00	5.00	4.01	0.19	3.58	4.25
Juiciness	3.95	0.29	3.40	4.40	3.91	0.48	3.00	4.67	3.85	0.27	3.42	4.42
Chewiness	3.84	0.19	3.60	4.20	3.77	0.49	3.00	4.67	4.09	0.44	3.50	4.92
Palatability	3.85	0.31	3.40	4.40	3.80	0.44	3.00	4.67	3.94	0.39	3.17	4.42
Overall score	3.94	0.15	3.72	4.12	3.90	0.24	3.20	4.20	3.91	0.22	3.47	4.20

SD – standard deviation, Min – minimal, Max – maximal, WHC – water holding capacity, CL – cooking loss.

Table 2
Coefficients and parameters of quadratic regression equations for estimating the quality parameters of ham using the same quality measurements made on loin.

Item	Intercept ± SE	β_1 ± SE	β_2 ± SE	F	R^2	p	Estimation error
pH	74.73 ± 18.29	−26.56 ± 6.93	2.55 ± 0.65	13.35	0.23	< 0.001	0.23
L*	236.66 ± 74.81	−6.52 ± 2.56	0.06 ± 0.02	3.45	0.07	0.035	2.88
a*	−342.43 ± 44.42	48.07 ± 5.93	−1.60 ± 0.19	32.89	0.43	< 0.001	0.73
b*	9.08 ± 7.57	−1.38 ± 2.19	0.14 ± 0.15	12.02	0.22	< 0.001	1.57
C*	172.12 ± 72.66	−19.01 ± 8.74	0.59 ± 0.26	7.89	0.15	< 0.001	1.36
H*	9.03 ± 16.52	0.46 ± 1.39	−0.01 ± 0.03	9.61	0.18	< 0.001	3.72
WHC (%)	−420.97 ± 101.21	35.58 ± 8.08	−0.69 ± 0.16	10.96	0.21	< 0.001	4.82
CL (%)	7.23 ± 19.75	1.12 ± 1.34	−0.01 ± 0.02	10.29	0.19	< 0.001	2.81
Taste	9.19 ± 2.39	−2.81 ± 1.19	0.37 ± 0.15	5.17	0.11	0.007	0.52
Flavor	7.68 ± 9.46	−1.33 ± 4.81	0.11 ± 0.61	2.95	0.06	0.058	0.50
Juiciness	7.75 ± 7.11	−1.42 ± 3.68	0.11 ± 0.47	5.18	0.11	0.007	0.46
Chewiness	12.16 ± 19.28	−5.24 ± 9.95	0.79 ± 1.28	6.91	0.14	0.001	0.47
Palatability	29.46 ± 6.52	−13.26 ± 3.44	1.71 ± 0.45	9.67	0.18	< 0.001	0.40
Overall score	7.87 ± 27.29	−1.63 ± 13.93	0.16 ± 1.78	2.87	0.06	0.062	0.24

WHC – water holding capacity, CL – cooking loss, SE – standard error, β_1 – regression coefficient measurement, β_2 – regression coefficient for measurement × measurement, F – F test, R^2 – determination coefficient, p – p-value.

was to determine the relationships between the quality evaluation of loin and quality evaluation of ham and belly from the same carcasses for trying to predict the quality parameters of ham and belly based on measurements made on the loin.

2. Material and methods

2.1. Design of the study

The research material consisted of 105 pork carcasses from a mass population of slaughtered pigs. The animals were slaughtered at the age of 6.5–7 months in a meat plant in Wielkopolska province, using the electric stunning method. Pre-slaughter time were similar for all animals: 5 h. The carcasses were bled, separated along the centre line and deprived of tongue, bristle, hooves, genital organs, perirenal fat, kidneys, diaphragm, eyes, middle ear, brain and spinal cord.

After 24 h cooling, from the same right half-carcasses were cut and marked three elements: loin, ham, and belly according to specific methodologies: I) loin was cut from the front from the thoracolumbar segment between the 4th and 5th thoracic vertebrae, from the top after the carcass dividing line, from the bottom along the anterior edge of the iliac bones leaving a 3 cm section below from the straight line of the lower limit of the muscle attachment of the *Longissimus* muscle to the ribs. Backfat from loin was cut off leaving only 2 mm; II) hams with shanks were cut off from pork carcasses and then adipose-meat tissue adhering to the hip bone was separated; fat-step fold was cut off; hip bones and halved vertebrae of the sacrum were excised so as not to damage the muscles of the ham; shranks in knee joint were removed with no damage to the gastrocnemius muscle; 1/5 part of the iliacus muscles were cut out with a knife in a circular motion so that the ham was rounded; III) belly with ribs was cut off from the half-carcass along with the lower ends of the ribs (from fifth to last) and part of the halved sternum with rib cartilages and the cutting lines were as follows: top - along half of the whole rib length; front – lines after cutting the shoulder and to the ventral part of the belly; down – lines after cutting the fat belt connecting the belly and to the ventral part of the belly, and rindless. During supplementary cutting, ribs, milk glands, and the rest of the ventral part of the belly were removed. The belly was profiled in a rectangular shape, and from the dorsal part the overgrowth of meat was about 2/3 of its length.

The samples for testing were vacuum-packed and transported in stable cooling conditions directly to the meat evaluation laboratory at the Institute of Animal Science, Wroclaw University of Environmental and Life Sciences, where they were then subjected to further analysis.