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PHYSICOCHEMICAL PROPERTIES OF MEAT FROM PORK CARCASSES OF DIFFERENT WEIGHT RANGES*

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The physicochemical properties of pork meat from carcasses of three different hot weight ranges, *i.e.* I – to 75 kg (n=28), II – from 75.1 to 95 kg (n=62) and III – over 95.1 kg (n=18) were investigated. It was found that the proportion of the high meatiness classes E and U declines together with the increase in carcass weight. In group I (up to 75 kg) the share of these classes amounted to 70.8%, in group II – to 38.1% and in group III – to 22.3%. The results confirm a negative correlation between meatiness and carcass weight. Carcasses up to 75 kg had the highest meatiness (on average 49.5%), which decreased with the growth in carcass weight from 47.62% in group II to 46.77% in group III. Simultaneously with carcass weight increase the quality of meat deteriorated. The best physicochemical properties as well as the optimum fat content were found in meat from carcasses of hot weight up to 75 kg.

INTRODUCTION

Recently, there has been a tendency towards a gradual increase in average carcass weight, which in 2001 amounted to 81 kg. The reason for low slaughter weight of fatteners in 1998-2000 was a high negative correlation between carcass weight and meatiness.

The proportion of the primal cuts in carcass is different depending on the weights of slaughtered fatteners. The carcasses of fatteners slaughtered at low slaughter weight tend to have lower ham weight and loin eye area despite a high category. It was indicated that the meat content of carcasses declines in the final growth stage of fatteners [Borzuta, 2001].

According to some authors, best-quality meat can be obtained from fatteners between 35 and 45 kg. Heavier and lighter carcasses have lower quality parameters [Koćwin-Podsiadła, 1999]. Consequently, the completion of fattening should be based on the economic account, processing requirements regarding raw materials, and consumers' needs [Borzuta, 2001; Grześkowiak *et al.*, 1998].

Pork carcasses should have the greatest possible proportion of primal cuts and meat should be free from quality defects [Karamucki *et al.*, 2001].

The aim of this research was to evaluate the physicochemical properties of pork meat from carcasses of three different weight ranges.

MATERIALS AND METHODS

Research included 108 fatteners reared in central-east Poland. *Post-mortem* measurements included the determination of hot carcass weight with accuracy to 0.1 kg, and meatiness with the UltraFom 100 apparatus. Samples of meat from *M. longissimus lumborum* and *M. semimembranosus* were taken after overnight carcass chilling at a temperature of 2–4°C. The loin eye area was determined using a planimeter with the accuracy of 1 cm^2. Two parameters, *i.e.* pH and electric conductivity EC (mS/cm), were measured by means of the PQM I-KOMBI apparatus (INTEK company) directly in the muscular tissue. Measurements were taken twice, *i.e.* 45 min (pH_1 and EC_1 respectively) and 24 h (pH_2 and EC_{24}) after slaughter. Drip loss was measured 48 h *post mortem* [Wajda, 1986].

Meat colour, after a 30-min exposure to air, was evaluated by means of a colour saturation meter Minolta CR-310. Wide-angle illumination (broad-image illumination) was used in the measure head, geometry 0% projection angle and 50 mm measurement area. The results determined were calculated as arithmetic means of two measurements. The absolute results were given as tri-chromatic values in the colour space L*a*b* [CIE, 1976], where L* – metric lightness, a* – redness, b* – yellowness. The chromameter was calibrated on a white model plate CR-A44 with the calibration data Y=93.50, x=0.3114, and y=0.3190. Chemical composition was measured in meat samples using conventional methods, *i.e.* crude protein content by the Kjeldahl method with Büchi B-324 equipment, and fat content by the Soxhlet method with the Büchi B-811 apparatus.

Statistical analysis was carried out on the basis of one-way analysis of variance, distinguishing 3 groups with regard to hot carcass weight: I – to 75 kg (n=28), II – from 75.1 to 95 kg (n=62) and III – over 95.1 kg (n=18). The significance of differences between the means in respective groups was verified by the Duncan test.

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RESULTS AND DISCUSSION

Figure 1 presents carcass structure in the EUROP classification within the agreed weight ranges. The proportion of the high meatiness classes E and U was found to decline together with the growth in carcass weight. In group I (up to 75 kg) the total share of these classes amounted to 70.8%, in group II – to 38.1% and in group III – to 22.3%.

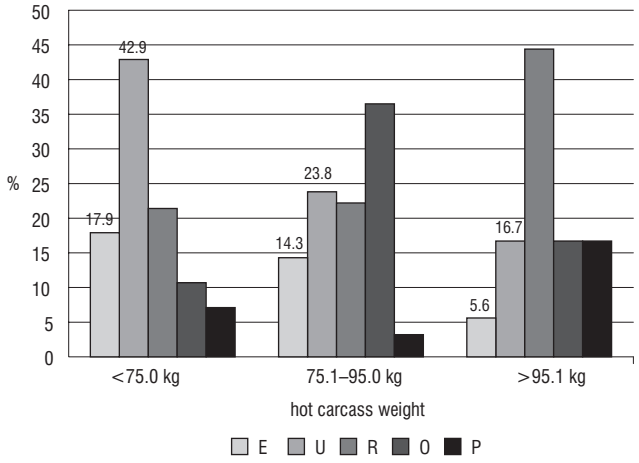

FIGURE 1. EUROP classification structure in respective weight ranges of the carcasses examined.

Carcasses qualified to the first weight range (up to 75 kg) had the highest meatiness, which amounted to 49.5% on average and decreased with the increase in carcass weight through 47.62% in group II to 46.77% in group III (the heaviest).

The results of the present research confirm the negative correlation between meatiness and carcass weight. Lisiak and Borzuta [2001] have already observed this adverse effect, which results from thinner back fat in younger animals. Thus at meatiness measurements their carcasses are usually qualified to higher EUROP classes.

Gajewczyk [2000] stated that the new settlement system for livestock introduced to the meat industry in Germany is based upon a fattener model with meatiness of 56% and *post mortem* weight within 82–100 kg; and meatiness bonus is paid only above 58%.

The loin eye area was observed to increase with the increase in carcass weight. Its average value in group I was 43.82 cm^2, in group II – 51.26 cm^2, and in group III – 59.27 cm^2 (Table 1).

Evaluating the quality of *m. longissimus lumborum*, the highest initial pH value (6.26) was observed for meat from the lightest carcasses (Table 2). The ultimate pH value was the lowest reaching 5.39. Electric conductivity measured 45 min after slaughter differed significantly ($p<0.01$) and amounted to 3.68, 4.41, and 4.74 in groups I, II and III, respectively. Its values measured 24 h after slaughter also differed significantly. The highest values were determined in meat from the heaviest carcasses (14.20 mS/cm).

Monin *et al.* [1999] did not indicate the influence of carcass weight on pH_1 and pH_{24}. For light slaughter weight (101 kg), these parameters amounted to 6.08 and 5.57, respectively, and for heavy weight (about 127 kg) – to 6.02 and 5.54, respectively.

TABLE 1. Basic slaughter traits of the carcasses examined.

Specification		Weight ranges of carcasses		
		up to 75 kg	from 75.1 to 95 kg	above 95 kg
Hot carcass weight (kg)	$\bar{x}$	68.56^{A}	85.02^{B}	103.73^{C}
	s	5.11	5.13	6.75
Meatiness (%)	$\bar{x}$	49.5	47.62	46.77
	s	6.31	5.64	5.31
Loin eye area (cm^2)	$\bar{x}$	43.82^{A}	51.26^{B}	59.27^{C}
	s	8.30	8.84	13.11

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

TABLE 2. Physicochemical properties of *M. longissimus lumborum* depending on carcass weight.

Specification		Weight ranges of carcasses		
		up to 75 kg	from 75.1 to 95 kg	above 95 kg
pH_1	$\bar{x}$	6.26	6.21	6.03
	s	0.37	0.37	0.39
pH_2	$\bar{x}$	5.39^{a}	5.48^{b}	5.49^{b}
	s	0.15	0.16	0.20
EC_1	$\bar{x}$	3.68^{A}	4.41^{B}	4.74^{B}
	s	0.59	1.72	2.00
EC_2	$\bar{x}$	9.02^{A}	14.13^{B}	14.20^{B}
	s	6.33	4.09	2.98
Drip loss (%)	$\bar{x}$	3.21	4.66	6.11
	s	1.76	2.10	2.50
CIE				
L*	$\bar{x}$	53.51^{ab}	51.89^{a}	54.76^{b}
	s	3.83	2.83	3.05
a*	$\bar{x}$	15.58	16.13	15.81
	s	1.49	0.88	1.21
b*	$\bar{x}$	5.63	5.01	5.86
	s	1.77	1.41	1.45
Crude protein (%)	$\bar{x}$	24.29	23.90	24.34
	s	4.17	2.58	4.16
Fat (%)	$\bar{x}$	2.89^{a}	3.27^{ab}	4.16^{b}
	s	1.27	1.29	0.98

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

The research indicated that the water holding capacity (WHC) of meat decreased with the growth in carcass weight. Meat from *M. longissimus lumborum* of the lightest carcasses had the lowest drip loss (3.21%). This parameter increased with carcass weight and amounted to 4.66% in group II and 6.11% in group III. The same relationship was found for the *semimembranosus* muscle (Table 3).

Szmańko *et al.* [2000] stated that pig muscular tissue of *M. longissimus dorsi* with the highest WHC had the lowest cross-section area and muscle fiber diameter. In contrast Mazaraki *et al.* [1968] demonstrated that the increase in the thickness of muscle fibers is determined, to the highest extent, by the body weight of fatteners, regardless of their age.

The results concerning lightness of meat show that loins from carcasses between 75 kg and 95 kg were significantly darker (L*=51.89). The average value of L* was 53.51 and 54.76 in groups I and III, respectively.

TABLE 3. Physicochemical properties of *M. semimembranosus* depending on carcass weight.

Specification		Weight ranges of carcasses		
		up to 75 kg	from 75.1 to 95 kg	above 95 kg
pH_1	$\bar{x}$	6.30	6.17	6.14
	s	0.29	0.35	0.345
pH_2	$\bar{x}$	5.54	5.61	5.461
	s	0.30	0.17	0.20
EC_1	$\bar{x}$	7.73^{a}	5.67^{ab}	6.56^{b}
	s	1.01	2.90	0.96
EC_2	$\bar{x}$	10.34^{A}	14.29^{B}	14.72^{B}
	s	5.05	3.89	3.69
Drip loss (%)	$\bar{x}$	1.75^{a}	3.10^{ab}	4.43^{b}
	s	0.6	1.62	1.60
CIE				
L*	$\bar{x}$	48.38	48.85	48.93
	s	3.22	3.22	2.62
a*	$\bar{x}$	16.02	16.70	16.83
	s	2.08	1.97	1.47
b*	$\bar{x}$	4.05	4.02	4.23
	s	2.67	2.00	1.52
Crude protein (%)	$\bar{x}$	21.92^{A}	22.64^{A}	24.63^{B}
	s	1.16	2.32	5.05
Fat (%)	$\bar{x}$	2.18	2.17	2.67
	s	1.20	0.92	1.68

Means in rows marked by different letters differ significantly: a,b – at $p \leq 0.05$, A,B – at $p \leq 0.01$

Nold *et al.* [1999] evaluated the influence of slaughter weight of fatteners on muscle traits. They found that *M. longissimus lumborum* from 100-kg fatteners was lighter and more yellow, L*=49.1 and b*=9.0, respectively. The red colour content was lower, *i.e.* a*=13.9 in comparison with fatteners slaughtered at 110 kg, *i.e.* L*=44.0, b*=8.2 and a*=16.1.

Corino *et al.* [2002] determined even lower L* and a* values 46.1 and 11.62, respectively when analysing *M. longissimus lumborum* of carcasses exceeding 135 kg.

Assessment of the *semimembranosus* muscle (Table 3) did not show any significant differences, either in the initial or ultimate pH. Yet, the electric conductivity measured 45 min and 24 h after slaughter indicated similar relationships as in the case of *M. longissimus lumborum*. The lowest EC_1 was found in the muscles obtained from the lightest carcasses (group I), the average being 4.73, and increased with carcass weight reaching 5.67 in group II and 6.56 in group III. EC_2 displayed a similar dependence: it was the lowest in the lightest carcasses (10.34 mS/cm) and the highest in the heaviest ones (14.72 mS/cm).

Gispert *et al.* [2000] evaluated the quality of the *semimembranosus* muscle of pigs delivered to 5 slaughterhouses. Their results obtained for the ultimate pH and electric conductivity measured 1 h after slaughter were 5.6–5.9 and 4.0–4.7 mS, with the average carcass weight from 76.2 to 82.6 kg.

The analysis of drip loss in *M. semimembranosus* indicated, similarly as in *M. longissimus lumborum*, the lowest values in group I (up to 75 kg) – 1.75 % and the highest ones in group III (over 95 kg) – 4.43%. No significant differences were found for the colour parameters of the *semimembranosus* muscle.

Nold *et al.* [1999] noted the influence of slaughter weight on meat colour, *i.e. M. semimembranosus* of 100-kg fatteners was lighter and more yellow (L*=49.1 and b=7.1, respectively). A lower share of the red colour (a*=13.9) was observed compared with fatteners slaughtered at the weight of 110 kg (L*=47.7, b*=5.8 and a*=16.1).

The analysis of the chemical composition of *M. longissimus lumborum* (Table 2) proved a significant growth in the fat content with the increase in carcass weight, from 2.89% in group I to 4.16% in group III. The protein content was found to increase in *M. semimembranosus*, from 21.92% in group I to 24.63% in III (Table 3).

Nold *et al.* [1999] reported an increase in fat and dry matter contents of *M. longissimus lumborum* depending on slaughter weight. Corino *et al.* [2002] observed the following contents of dry matter, fat and protein: 28.24, 3.64 and 23.52%, respectively in loins from carcasses above 135 kg. According to Koćwin-Podsiadła [2000], heterozygotic fatteners should be slaughtered at 110 kg to improve the quality of their meat.

CONCLUSIONS

1. The results of the present study indicate that carcass weight influenced the quality traits of pork. Meat quality was observed to deteriorate with carcass weight increase.

2. The best physicochemical properties and the optimum fat content, both for *M. longissimus lumborum* and *M. semimembranosus* muscles, were found in meat from carcasses of hot weight up to 75 kg.

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WŁAŚCIWOŚCI FIZYKOCHEMICZNE MIĘSA UZYSKANEGO Z TUSZ WIEPRZOWYCH O ZRÓŻNICOWANEJ MASIE

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Celem pracy była ocena właściwości fizykochemicznych mięsa wieprzowego uzyskanego z tusz zaliczonych do trzech różnych przedziałów masy przedubojowej tj. I – do 75,0 (n=28); II – od 75,1 do 95,0 (n=62) i III – powyżej 95,1 kg (n=18). Określono masę tuszy ciepłej (nie wychłodzonej) i mięsność (aparatem UltraFom 100). Po 24 godz. wychłodzeniu wykonano obrysy powierzchni przekroju poprzecznego mięśnia najdłuższego na kalce technicznej, które następnie planimetrowano. Pobierano również próbki mięsa z części lędźwiowej mięśnia najdłuższego i m. półbłoniastego. Za pomocą aparatu PQM I-KOMBI firmy INTEK GmbH, oznaczano dwukrotnie, tj. 45 min. i 24 godz. po uboju – pH i przewodność elektryczną właściwą. Po 48 godz. *post mortem* oznaczono wyciek naturalny. Barwę mięsa (wartości L*a*b*) po 30 minutowej ekspozycji, oceniano za pomocą miernika nasycenia barwy Minolta CR-310. W próbkach mięsa oznaczono metodami konwencjonalnymi zawartość białka ogólnego (metodą Kjeldahla zestawem Büchi–B324) i tłuszczu (metoda Soxhleta aparatem Büchi–B811).

Stwierdzono malejący udział klas o najwyższej mięsności, tj. E i U, wraz ze wzrostem masy tuszy. W grupie I (do 75 kg), łączny udział tych klas wyniósł 70,8%, w II grupie 38,1% a w III grupie 22,3% (rys. 1). Uzyskane wyniki potwierdzają ujemną zależność pomiędzy mięsnością, a masą tuszy. Tusze tuczników z pierwszego przedziału masy (do 75 kg) charakteryzowały się najwyższą mięsnością – średnio 49,5%, która zmniejszała się wraz ze wzrostem masy tuszy od 47,62% w grupie II, do 46,77% w grupie III (tab. 1). Wykazano wpływ masy tuszy na cechy jakościowe ocenianych mięśni. Wraz ze wzrostem masy tuszy obserwowano pogorszenie wyróżników jakości (tab. 2 i 3). Najlepszymi właściwościami fizykochemicznymi i optymalnym udziałem tłuszczu wewnątrzmięśniowego charakteryzowało się mięso pochodzące z tusz ciepłych, tj. niepoddanych poubojowemu wychłodzeniu, o masie do 75,0 kg.