Scientific Annals of Polish Society of Animal Production - Vol. 11 (2015), No 1, 93-102

The influence of hot carcass weight on meatiness and selected quality characteristics of the meat of pigs selected from the total population

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The aim of the study was to assess the influence of groups differentiated by hot carcass weight (HCW) on carcass meatiness and pork quality characteristics. The study was conducted in the spring/summer season on 100 fattening pigs selected from the total population. The animals were slaughtered by electric stunning and horizontal bleeding, in accordance with the technology applied at the meat processing plants. Three groups were distinguished on the basis of hot carcass weight: group I <80 kg; group II – 80-90 kg; group III >90 kg. Analysis of the influence of groups differentiated by hot carcass weight on carcass meatiness and the physicochemical properties of the pork showed that an increase in HCW from an average of 74 to 93 kg resulted in a significant (P≤0.01) decrease in carcass meatiness (about 5 p.p.) in the group of the heaviest pigs, while normal meat quality traits were preserved, except for pH_2 and meat lightness. As HCW increased, a decrease was observed in pH_2 (by about 0.13-0.15 units) and meat darkness (by about 3 units) in comparison to group I (HCW <80 kg). An increase in HCW was accompanied by a decrease in the frequency of carcasses with normal meat (about 6 p.p.) and a significant increase in the frequency of carcasses with acid meat (about 8 p.p.). Moreover, as HCW increased a significant reduction (about 22 p.p.) was observed in the frequency of carcasses with dripping meat (according to the 4% drip loss threshold widely used in Europe) in the heaviest pigs (HCW >90 kg).

KEY WORDS: fatteners / hot carcass weight / meatiness / meat quality

The domestic meat industry requires that pork should satisfy high quality parameters, with high meat content in the carcass, while at the same time pigs with higher body weight are preferred for slaughter [27]. Although light carcasses have higher meatiness, there is an increase in cost associated with the need to slaughter more animals in order to obtain the same weight of meat from primal cuts [32]. Material derived from the slaughter

of heavier pigs, although usually characterized by lower lean meat content, is more attractive commercially and easier to process [7, 20, 32].

The aim of the study was to determine the effect of groups differentiated by hot carcass weight (HCW) on the meat content of carcasses and selected quality traits of the meat of fattening pigs.

Material and methods

The study was conducted on 100 fattening pigs (with an equal sex ratio) from the mass population, obtained from farms supplying pigs to a meat plant in east-central Poland. The pigs were slaughtered in the spring/summer period. Following transport and a 2-4-hour rest period the pigs were stunned with a Stork (Netherlands) automatic electric stunner (Inarco system) and bled in a horizontal position, according to the technology used in the plant. The animals were randomly selected for analysis. Hot carcass weight was determined (to within 0.1 kg) on a track scale 35 minutes after slaughter. The percentage content of meat was estimated in hot, suspended half-carcasses (35 minutes after slaughter), using an ULTRA FOM 300 apparatus manufactured by the Danish company SFK-Technology. Three groups were distinguished on the basis of HCW: group I <80 kg, group II – 80-90 kg, and group III >90 kg (Fig. 1).

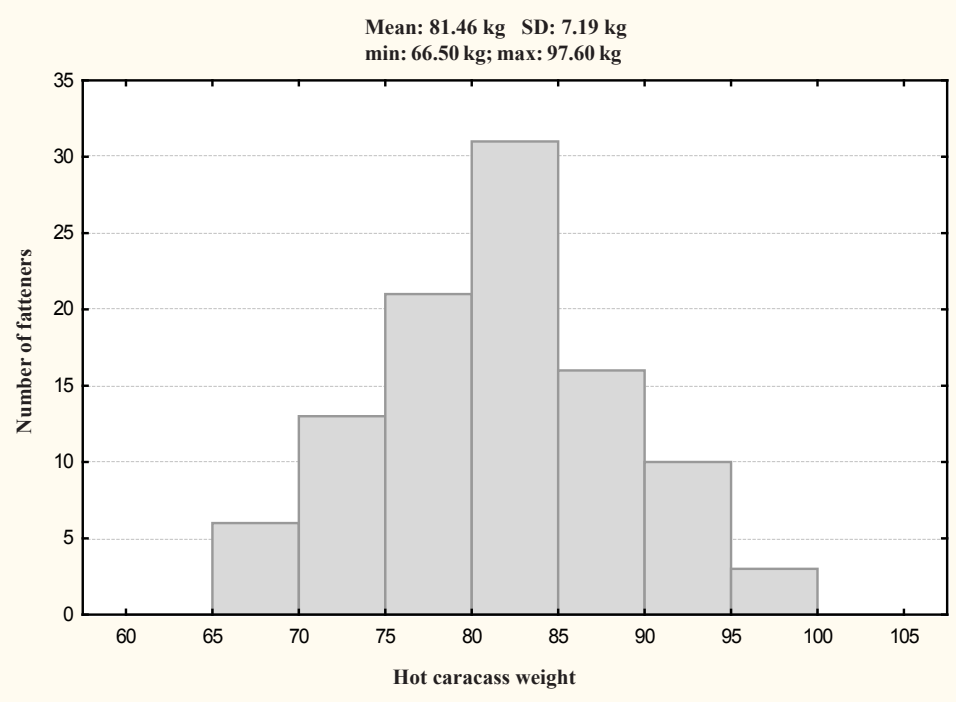

Fig. 1. Distribution of hot carcass weight (n=100)

Meat quality was evaluated after slaughter in the longissimus lumborum muscle (LL), on the basis of the following parameters: acidity of the muscle tissue (pH), electrical conductivity (EC), rate of breakdown of ATP expressed as the R_1 value (R_1 =IMP/ATP), lightness of colour (L*), drip loss, and water-holding capacity (WHC).

The pH of the meat was measured directly in the tissue of the LL muscle at 35 min, 2 h and 24 h post mortem, using a Dramiński MASTER pH-meter. Electrical conductivity was measured with a Matthaüs LF-Star conductivity probe at 35 min and 24 h after slaughter. The lightness (L*) of the meat tissue was determined using a Minolta CR310 apparatus 24 h after slaughter. The R_1 value was determined 45 min post mortem according to Honikel and Fischer [8]. HCW was determined 24 h post mortem according to Grau-Hamm [6], with a modification by Pohja and Ninivaary [23], and drip loss according to Prange et al. [24] at 48 h post mortem.

The threshold values for basic meat quality criteria, determined in the LL muscle (pH_{35}, pH_{24} and R_1), were used to diagnose four quality classes post mortem (see List): RFN (reddish-pink, firm, non-exudative); PSE (pale, soft, exudative); AM (acid meat); and DFD (dark, firm, dry).

List

Threshold values for selected meat quality parameters [10, 11, 12]

Specification	Meat quality classes			
	RFN	PSE	AM	DFD
pH_{35}	≥6.0	<6.0	≥6.0	≥6.0
pH_{24}	5.6-5.7	5.5-5.7	<5.5	≥6.0
R_1	<1.05	≥1.05	<1.05	≥1.05

In addition, two meat quality classes were distinguished on the basis of the drip loss from the LL muscle at 48 h post mortem, assuming a threshold value of DL_{48} =4.0%: I – non-exudative meat (DL_{48} ≤4.0%); and II – exudative meat (DL_{48} >4.0) [1]. The frequency of each meat quality class was calculated as the percentage in the entire material and within groups distinguished by hot carcass weight.

The results obtained were analysed statistically by one-way analysis of variance with non-orthogonal comparisons, taking into account the factor investigated, i.e. the hot carcass weight group. The level of significance of differences between means was verified by Tukey's test [19].

Results and discussion

The mean percentage content of meat in the carcasses of the pigs was 52.16%, with an average hot carcass weight of 81.45 kg (Tab.). The material was distinguished by high

Table
The influence of hot carcass weight group on lean meat content and meat quality traits

Specification	Hot carcass weight group			Total n = 100	F_{emp} Level of significance
	I (<80 kg) n = 40	II (80-90 kg) n = 47	III (>90 kg) n = 13		
Hot carcass weight (kg)	74.40^{A} ±3.96	84.24^{B} ±2.61	93.10^{C} ±2.55	81.45 ±7.19	198.5 **
Lean meat content (%)	53.49^{B} ±5.08	52.11^{B} ±4.59	48.32^{A} ±3.44	52.16 ±4.91	6.04 **
pH_{35} LL	6.40 ±0.21	6.44 ±0.23	6.45 ±0.22	6.43 ±0.22	0.44 NS
pH_{2} LL	6.18^{b} ±0.30	6.16^{b} ±0.19	5.93^{a} ±0.26	6.14 ±0.30	3.76 *
pH_{24} LL	5.56 ±0.11	5.59 ±0.15	5.53 ±0.10	5.57 ±0.13	1.22 NS
R_{1}	0.95 ±0.04	0.96 ±0.06	0.98 ±0.07	0.97 ±0.05	0.73 NS
EC_{35} LL (mS/cm)	3.20 ±0.84	3.14 ±1.07	2.90 ±0.61	3.14 ±0.93	0.28 NS
EC_{24} LL (mS/cm)	2.98 ±1.22	2.93 ±1.05	2.61 ±0.93	2.91 ±1.10	0.57 NS
Meat lightness (L*)	55.48^{B} ±3.55	53.40^{A} ±3.54	52.51^{A} ±3.05	54.11 ±3.64	5.44 **
Drip loss (%)	8.18 ±2.75	7.,40 ±2.73	7.30 ±2.71	7.73 ±2.74	1.30 NS
WHC (cm^2)	5.88 ±1.41	5.65 ±1.48	5.98 ±1.06	5.78 ±1.40	0.45 NS

The table presents F_{emp} and level of significance: **P≤0,01; *P≤0,05; NS – no significant differences. The data shown in the table are arithmetic means ±standard deviation; A, B – means differing significantly at P≤0.01; a, b – means differing significantly at P≤0.05

variation in the main factor analysed, i.e. hot carcass weight (from 65 kg to 100 kg, with a mean standard deviation of 7.19 kg) (Tab., Fig. 1). In Lisiak et al. [18] noted very similar meat content to that obtained in the present study in the carcasses of pigs from the mass population, at 52.3%.

In terms of glycolytic transformations, expressed as acidification of the LL muscle tissue at 35 min, 2 h and 24 h post mortem, energy conversions expressed by the R_1 index, electrical conductivity at 35 min and 24 h post mortem, and lightness, the meat of the pigs analysed was of good quality (Tab.). The mean values for these quality parameters, as reported by Koćwin-Podsiadła [10] and Koćwin-Podsiadła et al. [12], were within the range for good-quality meat, considered to be normal. A reflection of the results presented is the low percentage of carcasses with PSE and DFD meat, at 2% (Fig. 2). The very low

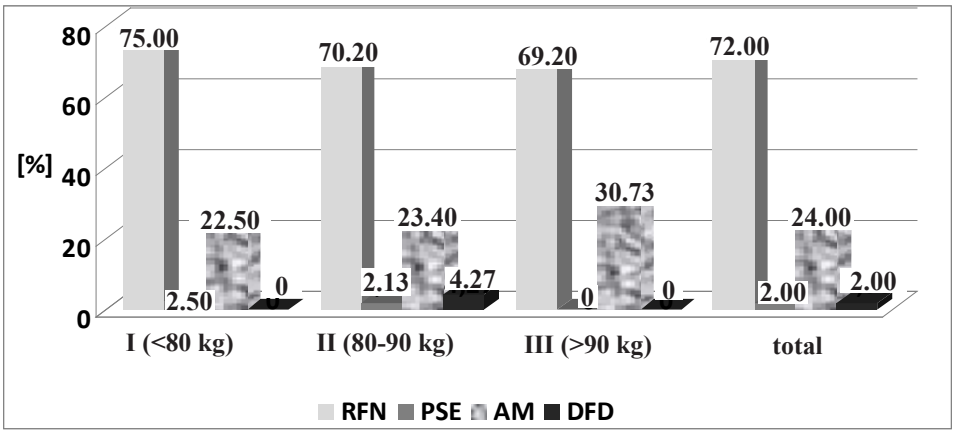

Fig. 2. Frequency of meat quality classes – total and by groups differentiated by HCW

percentage of carcasses with PSE meat may suggest that the pigs analysed were genetically resistant to stress and were ensured good slaughter conditions. The low percentage of carcasses with DFD meat, on the other hand, may be the result of optimal pre-slaughter handling conditions. Similar results for the frequency of defective meat were obtained by Przybylski et al. [25]. The authors cited analysed 390 pig carcasses (Naïma x P-76 crosses), of which carcasses with PSE meat accounted for 2.31% and those with partially DFD meat for 2.56%.

In the present study it is worth noting the degree of acidification of the muscle tissue 24 h post mortem. This parameter, with an arithmetic mean of 5.57, which is within the range for normal meat (see List), was characterized by high variability, expressed as a mean standard deviation of 0.13 units (Tab.). A consequence of the high variation in pH_{24} in the material was a high (24%) frequency of carcasses with defective meat of the acid meat type (AM), with pH_{24} below 5.5 (Fig. 2). The results suggest that among the pigs analysed there were some with a contribution of the Hampshire breed, with the dominant RN^- gene responsible for acid meat [4, 17, 21, 26].

The loss of meat juices from the muscle tissue during storage requires detailed analysis. Excessive drip loss from meat reduces its potential for sale as unprocessed meat. In the population analysed the drip loss (DL) from the LL muscle 48 h post mortem was high (DL=7.73%) and the water-holding capacity of the meat was low (WHC=5.78 cm^2), which was confirmed by the very high frequency of carcasses with exudative meat (67.0%) (Tab., Fig. 3).

Wide variation in drip loss from the muscle tissue was noted by Bertram et al. [1] in pigs from the mass population in Denmark. The authors found that in the case of mean

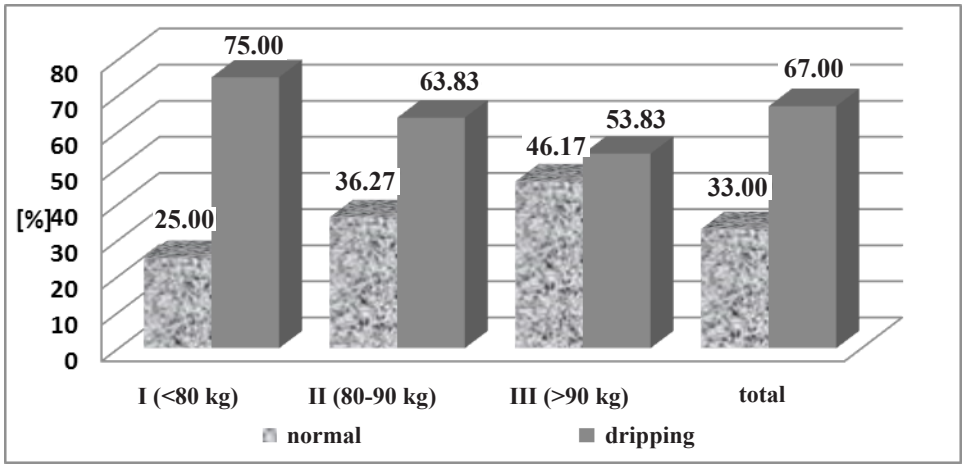

Fig. 3. Frequency of dripping meat – total and by groups differentiated by HCW

carcass weight of 75.3 kg, the drip loss from the muscle tissue 48 h after slaughter ranged from 2% to 16%, and the frequency of carcasses with exudative meat was about 90%. Wide variation in drip loss from the LD muscle of fattening pigs from the mass population was also noted by Krzęcio et al. [14]. In that study the drip loss 48 h after slaughter ranged from 1% to 15%, with a hot carcass weight of 81.3 kg, and the frequency of carcasses with exudative meat was 65%.

One-way analysis of variance revealed that the factor tested, i.e. hot carcass weight, influenced the meat content in the carcass ($P \leq 0.01$) and two meat quality characteristics: the pH of the LL muscle 2 h post mortem ($P \leq 0.05$) and meat lightness ($P \leq 0.01$)—Table.

As hot carcass weight increased (from 74 to 93 kg on average), a significant decrease in meat content was observed (by 5 p.p.) in the heavier pigs (HCW >90 kg)—Table. Numerous authors have reported a similar decrease in the percentage content of meat in the carcass as the slaughter weight of pigs from the mass population increased [5, 20, 22, 31]. Studies by Koćwin-Podsiadła et al. [13], Krzęcio et al. [15] and Sieczkowska et al. [27] on crosses of Danish breeds (with a 50% share of the Duroc breed on the paternal side) have shown that stabilization of the percentage meat content in the carcass is possible in the case of slaughter of heavier pigs (HCW 90-92 kg).

Analysis of the effect of hot carcass weight on meat quality characteristics revealed that as hot carcass weight increased there was a significant decrease in the pH_2 of the LL

muscle (of about 0.13-0.15) and a darkening of the meat (of about 3 units) as compared to group I (HCW <80 kg)—Table. The darker meat colour of the heavier pigs may be linked to the content of myoglobin in the muscles, which increases with the age of the animals [3, 16]. On the other hand, no statistically confirmed relationship between meat colour and carcass weight was noted by Candek-Potokar et al. [2], Koćwin-Podsiadła et al. [13], Sieczkowska et al. [28] or Weatherup et al. [30].

Although the present study did not demonstrate a statistically confirmed influence of hot carcass weight on the pH_{24} of the LL muscle, and the mean values noted in individual HCW groups were within the range for normal meat (group I – 5.56, group II – 5.59 and group III – 5.53), the variation (expressed as mean standard variation) for this parameter within each group was fairly wide, ranging from 0.10 to 0.15 (Tab.). These tendencies were confirmed by the fairly high percentage of carcasses with acid meat. As hot carcass weight increased there was a significant increase (of about 8 p.p.) in the percentage of carcasses with acid meat (from 22.50% in group I to 30.73% in group III), accompanied by a decrease (of about 6 p.p.) in the percentage of carcasses with normal meat (from 75% in group I to 69.2% in group III)—Fig. 2.

In the analysed population of pigs, despite the lack of a significant effect of the factor tested, i.e. HCW group, on the drip loss 48 h post mortem, the drip loss from the LL muscle tissue showed a downward trend as HCW increased. The drip loss 48 h after slaughter in the experimental groups distinguished by HCW was typical for exudative meat: 8.28% in group I, 7.40% in group II and 7.30% in group III (Tab.). As in the present study, other authors [9, 15, 29] have found no significant effect of carcass weight on drip loss from the muscle tissue of fattening pigs. In an experiment by Koćwin-Podsiadła et al. [13], conducted on crossbred pigs of Danish breeds (Landrace x Duroc), an increase in hot carcass weight caused a considerable reduction in drip loss 48 h after slaughter.

In the present study the downward trend in drip loss as hot carcass weight increased was confirmed in the frequency of carcasses with exudative meat. As hot carcass weight increased a significant decrease was observed in the frequency of exudative meat (from 75% in group I to about 54% in group III)—Fig. 3.

To sum up, the analysis of the effect of the experimental factor, i.e. groups differentiated by hot carcass weight, on meatiness and meat quality characteristics, demonstrated that as hot carcass weight increased (from 74 kg to 93 kg on average) meatiness decreased significantly (by about 5 p.p.), while meat quality characteristics remained at a similar level. The two exceptions were pH_2 and meat lightness. As hot carcass weight increased there was a statistical decrease in pH_2 (of about 0.13-0.15) and the meat colour became darker (by about 3 units).

The results obtained clearly indicate that an increase in hot carcass weight (of about 20 kg on average) leads to an improvement in meat quality, making it more attractive to the consumer, as reflected in the darker colour and lower percentage of carcasses with exudative meat.

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