The effect of carcase conformation and fat cover scores (EUROP system) on the quality of meat from young bulls

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ABSTRACT

The EUROP classification system includes only a small number of indicators to characterise beef carcases, none of which directly describes meat quality. Therefore, beef producers show limited interest in improving meat quality parameters. The aim of this study was to evaluate whether conformation and fat cover, as assessed in the EUROP classification system, can be reliable descriptors of the qualitative characteristics of beef carcases and meat quality. A total of 198 carcases of young bulls were analysed. Meat samples were collected from the longissimus thoracis (LT) muscle. It was found that the muscle content of three-rib cuts was higher in better-conformed carcases. Conformation class was inversely related to intramuscular fat (IMF) content, the fat content of three-rib cuts and meat juiciness. Meat quality was better characterised by fat class than conformation class. The fat cover had a positive influence on shear force values, the water-holding capacity and tenderness of meat. The water-holding capacity of meat and shear force values can be used in addition to EUROP scores to more accurately characterise beef carcases.

HIGHLIGHTS

• Better conformed carcases have lower intramuscular fat content, lower fat content of three-rib cuts, higher shear force values and lower juiciness scores;
• Fat cover is a more reliable indicator of meat quality than carcase conformation;
• Water-holding capacity and shear force can be used in addition to EUROP scores.

Introduction

A rise in consumer awareness is accompanied by growing expectations for high-quality food products, including beef. The quality of bovine carcases is influenced not only by the selection of genetic material and production technology but also by the principles of cattle purchase (Wajda and Daszkiewicz 2000; Nogalski et al. 2014; 2016). The EUROP grid method of beef carcase classification was implemented in the European Union in 1981, pursuant to European Economic Community Regulations (EEC) No. 1208/81. This classification system, used in European abattoirs, includes only general indicators such as sex category, age, conformation score, fat score and hot carcase weight (Kien 2004). Beef carcases are classified based on a visual assessment of the following traits: carcase conformation including muscle content – the EU scale has six conformation classes (S, E, U, R, O, P), and fat content – the EU scale has five fat classes (where 1 is low-fat content and 5 is high-fat content). Unfortunately, the EUROP system is subjective and does not ensure a uniform classification across the EU countries or among the graders/classifiers (Borggaard et al. 1996). The lack of objective carcase grading discourages cattle breeders and beef producers from raising quality, and variations in quality levels are the main reason for the decline in beef consumption (Polkinghorne et al. 2008). In many countries, beef carcase classification systems are based on evaluating the quality attributes of cold carcases, the degree of marbling, colour and texture of selected muscles, ossification and ultimate pH (Commission Regulation EC 2008). In Europe, there is still no reliable online tool to predict beef quality and deliver consistent quality beef.
to consumers (Hocquette et al. 2014). In some countries, cattle are evaluated on purchase based on live ultrasound measurements of lean and fat content (Craigie et al. 2013) or using a video image analysis (VIA) system (Allen 2007). The uniform EUROP system has been introduced in the EU member states to improve the quality of bovine carcasses and meat at the stages of commercial cattle breeding and beef production. However, the EUROP system in its existing form may not meet the above goals (Nogalski et al. 2013; Bonny et al. 2016). The aim of this study was to evaluate whether conformation and fat cover as assessed in the EUROP classification system can be reliable descriptors of the qualitative characteristics of beef carcasses and meat quality. The experiment was performed on the carcasses of young bulls which account for 45% of cattle slaughtered in Poland (Janiszewski et al. 2015).

Materials and methods

Animals

The experiment was conducted upon the approval of the Local Ethics Committee for Animal Experimentation (decision No. 121/2010).

The study was conducted in 2013–2015. The experimental materials comprised 198 young crossbred beef bulls produced by crossing Holstein-Friesian (HF) cows with Limousin (LIM) bulls (67 HF × LIM crosses), Hereford (HH) bulls (65 HF × HH crosses) and Charolais (CH) bulls (66 HF × CH crosses). Calves of known origin purchased at 2 or 3 weeks of age were placed in a rearing facility at the Agricultural Experiment Station in Balcyny. The calves were fed milk replacer, hay and concentrate, followed by grass silage. Starting from six months of age, the animals were fattened in a semi-intensive production system. Daily gain ranged from 800 to 950 g. Silage made from wilted grass (first cut) supplemented with concentrate (rapeseed meal, ground triticale, minerals) was provided ad libitum.

Carcass quality

At the end of the fattening period, the animals were transported to a meat processing plant where they were kept in individual boxes with access to water for 15 to 20 h. The animals were weighed before slaughter and stunned, the carcases were dressed and halved along the spine into two half-carcasses that were chilled for 96 h at 4 °C. Electrical stimulation was not applied to the carcases. The value of pH48 was measured after 48 h of carcass chilling, in the longissimus thoracis (LT) muscle, between the 10th and 11th thoracic vertebrae. Half-carcasses were weighed within an accuracy of 0.5 kg, and conformation and fat coverage were evaluated based on the EUROP system criteria by a trained grader (Kien 2004). Ninety-six hours post-mortem, three-rib (10th–12th rib) sections were sampled from right half-carcasses (two cuts through a half-carcase, perpendicular to the spine, between the 9th and 10th, and the 12th and 13th thoracic vertebrae). Half-carcasses were divided into primal cuts in accordance with the Polish Standard of 2003 (PN-88/A-82003/Apl.). Five most valuable cuts, i.e. the shoulder, fore ribs, best ribs, loin and round of beef, were weighed and their percentage shares in the right half-carcase were estimated. Three-rib cuts were dissected, and the percentage content of soft tissues (lean meat, fat, tendons) and bones was determined.

Chemical composition, physical and sensory properties of the longissimus thoracis muscle

During carcase dressing, LT samples were collected from right half-carcasses 96 h post-mortem to evaluate beef quality. Meat samples weighing 300 g were packaged in PA/PE vacuum bags at an ambient temperature of around 4 °C, under standard industrial conditions. Meat colour was evaluated based on the values of components L°, a°, b° in the CIE LAB (CIE 1978) system, and the values of saturation index (C°) were calculated according to the formula \((a^2 + b^2)^{1/2}\). Colour space parameters L°, a° and b° were measured three times by the reflectance method, using the HunterLab Miniscan XE Plus spectrocolorimeter, at different points over the muscle cross-section area. Colour measurements were performed on meat samples stored for 30 min at 4 °C, covered with foil permeable to O₂ and impermeable to H₂O. After colour measurements, each meat sample was divided into two portions; the first portion was used to determine the proximate chemical composition and physico-chemical properties of meat, and the other portion was used to evaluate the sensory attributes of meat. The analysis of the proximate chemical composition of meat included the determination of dry matter, total protein, crude fat and ash, according to the procedure described by Nogalski et al. (2016). Water-holding capacity was determined based on natural drip loss and cooking loss. To estimate natural drip loss, 20 g meat samples were packaged in polyethylene string bags and placed in an incubator at a temperature of 4 ± 1 °C; after 24 h, the samples were dried and
weighed again; natural drip loss was calculated as the difference between sample weights before and after cold storage. Cooking loss was determined according to the method proposed by Honikel (1998). Warner-Bratzler shear force (WBSF) values (N) were measured using an Instron 5542 universal testing machine (Instron, Norwood, MA, USA) equipped with a shear blade. Cylindrical core samples (1.27 cm in diameter, 40 mm in length) were cut out with a cork borer in the direction of muscle fibres. The shear blade (V-shaped, with a triangular aperture of 60°) was applied perpendicularly to the fibre direction at a crosshead speed of 2 mm/s.

A sensory evaluation was performed in accordance with Polish Standard PN-ISO 4121 (1998). Meat samples weighing 200 g were cut out crosswise to muscle fibres and were cooked in a 0.6% NaCl solution (meat to solution weight ratio of 1:2) at a temperature of 96°C (±2°C) until the temperature inside the sample reached 75°C. The sensory attributes of coded meat samples (aroma, taste, juiciness and tenderness) were evaluated on a 5-point scale (where 1 and 5 denoted the minimum and maximum score, respectively) by five trained panellists, selected based on their flavour sensitivity. The samples were presented to the panelists at room temperature (20°C), in fluorescent light. The panellists assessed 10 meat samples during each session; each panellist received coded samples in the same order, and each sample was tested by all panellists.

Statistical analysis

Three conformation classes U, R and O were included in the analysis because only two carcases were assigned to class E and none of them was assigned to class P (Table 1). The fat classes ranged from 1 to 3. Data were processed statistically using Statistica software version 12 (StatSoft, Inc., 2014, Tulsa, OK, USA). The effect of genotype on the distribution of conformation and fat classes was estimated using a chi-squared test, and it was found to be not significant. The effects of conformation and fat classes on carcase traits and meat quality were determined by the GLM method – covariance analysis, using the formula:

\[ Y_{ijk} = \mu + A_i + B_j + (AB)_{ij} + cov (B)_{j} + cov (C)_{k} + e_{ijk} \]

where \( Y_{ijk} \): value of the analysed parameter; \( \mu \): population mean; \( A_i \): effect of conformation class; \( B_j \): effect of fat class; \( (AB)_{ij} \): conformation class x fat class interaction; \( C_k \): covariance effect of slaughter age; \( D_l \): covariance effect of hot carcase weight; \( e_{ijk} \): random error.

Results and discussion

Carcase quality

The majority of the evaluated bull carcases were assigned to conformation class R (119 carcases, 60.71%) and fat class 2 (95 carcases, 48.98%) (Table 1). Most bovine carcases purchased in Poland represent conformation class O (56.7%) and fat class 3 (54.3%) (Janiszewski et al. 2015). The above differences are due to the fact that the bulls evaluated in our experiment were produced by crossing dairy cows with beef bulls, whereas dairy Holstein-Friesian cattle predominated in bulk purchase. The carcases of older bulls received higher conformation scores and were significantly heavier than the carcases of younger animals. Better conformed carcases had significantly higher muscle content and lower bone content of three-rib cuts. The fat cover was significantly affected by the age at slaughter (Table 1). On average, the bulls whose carcases were assigned to fat class 1 were slaughtered at 521.5 days of age, and the bulls whose carcases were assigned to fat class 3 were slaughtered at 586.9 days of age. Carcases with higher fat cover scores were significantly heavier and had a lower

| Trait | Conformation class (Cc) | Fat class (Fc) | p value |
|-------|------------------------|---------------|---------|
|       | U | R | O | 1 | 2 | 3 | SE | Cc | Fc | CcxFc |
| Number of carcases | 31 | 119 | 46 | 35 | 95 | 66 | 4.995 | .002 | .000 | .131 |
| Age at slaughter, days | 577.700 | 563.200 | 528.000 | 521.500 | 549.000 | 586.900 | 3.128 | .000 | .000 | .138 |
| Hot carcase weight, kg | 326.000 | 288.900 | 260.900 | 271.500 | 280.800 | 307.200 | 3.010 | .000 | .000 | .211 |

Table 1. The influence of the class of conformation and fatness on the qualitative characteristics of young bulls’ carcases.
proportion of the most valuable cuts. The value of a carcase is significantly affected by tissue composition. In our study, higher fat cover scores were associated with a significant increase in the fat content and a decrease in the muscle and bone content of three-rib cuts. On average, three-rib cuts from carcases assigned to fat class 1 had 8.58% higher muscle content and 13.47% lower fat content than three-rib cuts from carcases assigned to fat class 3. Conroy et al. (2010) demonstrated that equations developed using hindquarter composition accurately predicted carcase meat, fat and bone proportions. In the current study, an analysis of three-rib cuts revealed that EUROPEP scores are related to the tissue composition of bovine carcases. Conformation classes reflect carcase lean content, and fat classes reflect carcase fat content.

**Chemical composition, physical and sensory properties of m. Longissimus thoracis**

Conformation class had no effect on the chemical composition or colour of meat, but it affected the sensory properties of meat (Table 2). Meat samples collected from class O carcases scored higher for tenderness and juiciness \( p \leq 0.05 \) than meat samples collected from U class carcases. Wajda and Daszkiewicz (2000) demonstrated that conformation class had no effect on the protein and fat content or the physicochemical properties (pH, colour lightness, water holding capacity) of the LD muscle. However, Florek and Litwińczuk (2001) noted deterioration in the physicochemical properties of meat from carcases assigned to lower conformation classes. In an American study (Bratcher et al. 2005), significant differences were observed in the tenderness of meat representing USDA Choice and Select classes (WBSF of 38.2 and 43.0 N, respectively) after seven days of ageing. In our experiment, the LT muscle from better-conformed carcases had higher water-holding capacity and WBSF values. Shear force, closely related to meat tenderness, is largely determined by the thickness of muscle fibres and post-mortem metabolism (Kołczak 2008). Meat from carcases with better conformation has thicker muscle fibres and lower tenderness (Crouse et al. 1991). An interaction between the factors was observed for WBSF. Meat from carcases with a better conformation class and a lower fat class had higher WBSF values. The colour of fresh meat is an important quality parameter that determines a consumer’s response and decision whether to buy a given product at retail or not. In the current study, conformation and fat classes were not appropriate descriptors of meat colour. However, according to Monteiels et al. (2017), meat colour and marbling are reliable indicators that could be included in the EUROPEP classification system. Consumers use colour and marbling as cues for making purchase decisions, but the sensory properties of meat contribute most to consumer scores (Polkinghorne et al. 2008). The negative influence of higher conformation classes on the juiciness and tenderness of meat, which was noted in our study, points to the limitations of the EUROPEP classification system. Similar results were reported by Guzek et al. (2014) who demonstrated that higher conformation classes had no positive effect on the content of IMF and collagen in meat or meat tenderness.

The fat class had a significant effect on the chemical composition of meat (Table 2). Meat samples collected from carcases assigned to fat class 3, compared

### Table 2. Features of meat quality depending on the conformation and fatness class of carcases.

| Trait                  | Conformation class (Cc) | Fat class (Fc) | SE | p value |
|------------------------|-------------------------|----------------|----|---------|
|                        | U           | R           | O  | 1      | 2      | 3      | Cc | Fc | CcxFc |
| pH_48                  | 5.560       | 5.530       | 5.540 | 5.580 | 5.570 | 5.500 | 0.020 | .150 | .186 | .474 |
| Dry matter, %          | 25.450      | 25.950      | 26.350 | 25.370 | 25.240 | 26.740 | 0.183 | .345 | .000 | .876 |
| Fat, %                 | 1.810       | 2.260       | 2.660 | 1.620 | 1.910 | 2.640 | 0.199 | .465 | .000 | .941 |
| Ash, %                 | 1.090       | 1.070       | 1.060 | 1.070 | 1.080 | 1.100 | 0.004 | .110 | .022 | .965 |
| Total protein, %       | 22.110      | 21.950      | 21.540 | 22.160 | 21.950 | 21.800 | 0.070 | .143 | .243 | .061 |
| WBSF [N]               | 45.200      | 44.600      | 38.900 | 45.750 | 44.040 | 43.160 | 1.595 | .047 | .048 | .029 |
| L                      | 34.490      | 35.720      | 36.550 | 34.780 | 36.130 | 35.290 | 0.341 | .189 | .350 | .265 |
| a                      | 18.020      | 18.850      | 18.880 | 19.640 | 17.950 | 19.160 | 0.300 | .548 | .082 | .789 |
| b                      | 13.190      | 14.330      | 14.490 | 13.690 | 14.390 | 14.090 | 0.451 | .509 | .785 | .702 |
| C                      | 22.330      | 23.800      | 23.800 | 22.940 | 23.130 | 23.799 | 0.359 | .365 | .395 | .732 |
| Drip losses, %         | 1.800       | 2.170       | 2.330 | 2.290 | 2.160 | 2.080 | 0.151 | .034 | .904 | .097 |
| Cooking losses, %      | 32.640      | 33.840      | 33.930 | 34.770 | 33.670 | 32.440 | 0.361 | .412 | .019 | .132 |
| Aroma                  | 4.140       | 4.420       | 4.650 | 3.990 | 4.160 | 4.560 | 0.085 | .151 | .121 | .242 |
| Tenderness             | 3.520*      | 3.690*      | 4.350* | 3.190* | 3.760* | 4.120* | 0.078 | .013 | .024 | .308 |
| Juiciness              | 3.850*      | 4.000*      | 4.300* | 3.940 | 4.050 | 4.160 | 0.052 | .043 | .089 | .893 |
| Taste                  | 4.500       | 4.630       | 4.800 | 4.250 | 4.400 | 4.460 | 0.046 | .165 | .134 | .356 |

WBSF: Warner–Bratzler shear force; L: lightness, a: redness, b: yellowness; C: chroma; within Cc and Fc A,B < 0.01; a,b < 0.05.
with carcases assigned to fat class 1, had lower WBSF values and higher water-holding capacity. Fat class affected \( p \leq 0.05 \) meat tenderness evaluated in a sensory analysis. Meat from carcases with higher fat cover received higher tenderness scores. Bovine carcases should have an optimal content of fat, in particular, IMF (Hocquette et al. 2010) which is a carrier of taste and aroma. Optimal IMF content, which varies across muscles, has a beneficial influence on the tenderness and juiciness of beef (Kolczak 2008). In the present study, conformation class had no effect on fat content, whereas subjectively evaluated fat cover (fat class) significantly affected actual IMF content. Meat samples collected from carcases assigned to fat class 3, compared with carcases assigned to fat class 1, had on average 1.72% higher fat content and, consequently, higher concentrations of dry matter and ash. European fat cover scores are also correlated with marbling score and IMF content. Conroy et al. (2010) reported a one unit increase in European fat cover score (using the full 15-point scale) as the proportion of total fat in the carcase (determined during carcase dissection) increased by 12.00 g/kg.

Fat classes in the EUROP system, which significantly affect IMF content, more accurately reflect the sensory properties of meat, in particular tenderness, which was also observed in the current study. Bonny et al. (2016), who analysed m. longissimus thoracis et lumborum, also observed an increase in overall liking for carcases from classes U to R and to O for tenderness.

**Conclusions**

The results of this study, conducted on 198 carcases of young bulls, indicate that EUROP scores were not reliable descriptors of the actual quality of bovine carcases and beef. Selected meat quality traits are better characterised by fat class than conformation class. The existing carcase classification system should be modified to include additional parameters in order to improve meat quality and ensure a fair payment system. The water-holding capacity of meat and shear force values can be used in addition to EUROP scores to more accurately characterise beef carcases.

**Disclosure statement**

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