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A comparison of the quality of the *Longissimus lumborum* muscle from wild and farm-raised fallow deer (*Dama dama* L.)

T. Daszkiewicz[a,*], N. Hnatyk[a], D. Dąbrowski[a], P. Janiszewski[b], A. Gugołek[b], D. Kubiak[a], K. Śmiecińska[a], R. Winarski[a], M. Koba-Kowalczyk[a]

[a] *Department of Commodity Science of Animal Raw Materials, University of Warmia and Mazury in Olsztyn, Oczapowskiego 5, 10-719 Olsztyn, Poland*

[b] *Department of Fur-bearing Animal Breeding and Game Management, University of Warmia and Mazury in Olsztyn, Oczapowskiego 5, 10-719 Olsztyn, Poland*

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ABSTRACT

The objective of the present study was to determine the chemical composition as well as the physicochemical and sensory properties of meat (*Longissimus lumborum* muscle) from wild fallow deer (*Dama dama* L.) bucks shot during a hunt in forests of north-eastern Poland ($n = 11$) and farm-raised fallow deer bucks ($n = 14$) slaughtered on a farm in north-eastern Poland. It was found that the number of samples with pH_u higher than 6.0 accounted for 57% of all samples collected in the group of farmed-raised fallow deer. Meat samples with pH > 6.0 were not taken into consideration while evaluating meat quality. Meat from wild fallow deer, compared with farmed animals, was characterized by a higher ($P \leq 0.01$) content of fat, a higher ($P \leq 0.01$) calorific value, a more desirable fatty acid profile, including higher ($P \leq 0.05$) concentrations of unsaturated fatty acids, lower ($P \leq 0.01$) average pH_u values, lower ($P \leq 0.05$) lightness (L^*) and higher ($P \leq 0.01$) color saturation resulting from a higher contribution of redness ($P \leq 0.01$) and yellowness ($P > 0.05$). Meat from wild fallow deer received also higher scores for aroma desirability ($P \leq 0.01$), taste desirability ($P \leq 0.05$), juiciness ($P \leq 0.05$) and lower ($P \leq 0.01$) scores for tenderness.

1. Introduction

Due to a decrease in the profitability of conventional farming, farmers search for alternative or additional sources of income such as deer farming. The number of deer farms has been rising steadily in recent years in response to increased demand for venison which has become popular among consumers owing to its specific sensory properties and a high nutritional value resulting from a low content of fat and cholesterol, and a high content of protein and minerals (Zomborszky et al., 1996; Daszkiewicz et al., 2009a, 2012; Hutchison et al., 2010; Purchas et al., 2010).

The estimated global population of farmed deer approaches 5 million. New Zealand accounts for over one-half of the world's production of farmed deer (Gill, 2007). Reindeer (*Rangifer tarandus tarandus*) are reared in semi-domesticated systems in Nordic countries (Finland, Sweden, Norway), Russia and Alaska (Malmfords and Wiklund, 1996). The most popular farm-raised deer species are the wapiti (*Cervus elaphus nelsoni*), the fallow deer (*Dama dama*), the sika deer (*Cervus nippon*) and the axis deer (*Axis axis*) in North America (USA, Canada), and the red deer (*Cervus elaphus*) and the fallow deer in Europe where the majority of deer farms are located in Germany and Great Britain (Hoffman and Wiklund, 2006).

* Corresponding author. Tel.: +48 089 523 43 84.
E-mail address: tomasz.daszkiewicz@uwm.edu.pl (T. Daszkiewicz).

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A considerable amount of literature has been published on deer carcass characteristics and game meat quality as affected by many factors such as: the time and conditions of chilled storage (Vergara et al., 2003; Wiklund et al., 2006), management and nutrition of farmed deer (Volpelli et al., 2003; Wiklund et al., 2003b), pre-slaughter handling (Jago et al., 1997), the age of animals (Sookhareea et al., 2001; Volpelli et al., 2003), the rut (Stevenson et al., 1992), electrical stimulation (Wiklund et al., 2001), slaughter methods (Pollard et al., 2002), and castration (Hogg et al., 1990). The questions that need to be asked are whether wild and farmed venison differs in quality and whether the latter can be perceived as a different meat product. In view of the above, the objective of the present study was to compare the chemical composition as well as the physicochemical and sensory properties of the *Longissimus lumborum* muscle from farm-raised and wild fallow deer (*D. dama* L.).

2. Materials and methods

2.1. Animals

2.1.1. Wild fallow deer

The experimental materials comprised the carcasses of fallow deer bucks hunter-harvested in the forests of north-eastern Poland. The animals were shot in November and December of 2011. Among the carcasses supplied to the meat processing plant, 11 carcasses were selected for analysis, based on the following criteria: the age of animals at harvest—17–18 months, the age of animals was estimated based on the wear of mandibular premolars and molars (Morow, 1993) and on the fact that calving took place in June and July of the year preceding the experiment); the time that passed from the harvest of animals to carcass cutting—48 to 54 h; no bullet damage to the *Longissimus dorsi* muscle; no carcass contamination due to damage to the digestive tract (bullet damage or incorrect evisceration procedure); correct carcass chilling (temperature measured at the geometric center of the thickest portion of the leg – not higher than 7 °C); acidity of the *L. dorsi* muscle (at the last rib) – ultimate pH values ≤6.0, to eliminate dark, firm, and dry meat (DFD).

2.1.2. Farm-raised fallow deer

Eighty fallow deer were raised, from birth until slaughter, on natural pasture in a farm in north-eastern Poland. Throughout the year, the animals had unlimited access to pasture (stocking density – 16 deer/ha). In the winter and spring season (from December to May), their diet was supplemented with a cereal mixture (ca. 0.5 kg/animal) and haylage (ad libitum). The animals had free access to water and mineral licks throughout the year.

Between November and December of 2011, 14 randomly selected fallow deer aged 18 months (their age was estimated based on farm records and rings) were slaughtered on the farm, under veterinary control, in accordance with the Regulation of the Minister of Agriculture and Rural Development of 9 September (2004) on the qualifications of persons qualified for professional slaughter and the conditions and methods of animal slaughter and killing (Journal of Laws of 2004, No 205, item 2102). The animals were held still in a crush, stunned with a captive bolt gun (Radical), and bled out by cutting the carotid artery. The carcasses were transported to a meat processing plant (refrigerated truck – 4 °C, time of transportation – ca. 1 h) where they were subjected to veterinary examination after evisceration and hide removal. Chilled carcasses (2–3 °C, 48 h) were dressed.

2.2. Preparation of meat samples

Samples of the *L. lumborum* muscle cut out of the right side of each carcass (at the last rib) of hunter-harvested and farm-raised fallow deer were packaged in polyethylene bags and transported to the laboratory in isothermal containers with ice. Samples were analyzed immediately to determine the chemical composition and physicochemical and sensory properties of meat.

2.3. Research methods

2.3.1. Chemical measurements

The analysis of the proximate chemical composition of meat included the determination of dry matter content, total protein content by the Kjeldahl method, fat content by the Soxhlet method and ash content (AOAC, 1990).

The energy value of meat was calculated with the use of individual energy factors for protein – 4.00 kcal (16.78 kJ) and fat – 9.00 kcal (37.62 kJ), according to Jankowska et al. (2005).

Total lipids were extracted in a chloroform: methanol (2:1) mixture as described by Folch et al. (1957). The fatty acid composition of intramuscular fat was determined by esterification (Peisker, 1964) followed by gas chromatography using a VARIAN CP-3800 chromatograph. Separation parameters were as follows: a flame ionization detector (FID), capillary column—length: 50 m, inner diameter: 0.25 mm, liquid phase—CP-Sil 88, film thickness—0.25 μm, carrier gas—helium, carrier gas flow rate—1.2 ml/min.

2.3.2. Physicochemical traits

The pH of each sample was measured approximately 54 h *post mortem* in the water homogenates of meat (10 g of meat was homogenized with 10 cm^3 of distilled water using an IKA Ultra Turrax® T25 digital homogenizer at around 1/4 speed with 3 × 5 s bursts), using a combination Polilyte Lab electrode (Hamilton) and an inoLab Level 2 pH-meter equipped with a TFK 325 temperature sensor (WTW).

Meat color was determined based on the values of CIELAB coordinates, L^* (lightness), a^* (redness), b^* (yellowness), C^* (chroma) (CIE, 1978). The color space parameters L^*, a^* and b^* were measured three times by the reflectance method using a HunterLab MiniScan XE Plus spectrocolorimeter (Hunter Associates Laboratory Inc., Reston, VA, USA) with standard illuminant D65, a 10° standard observer angle and a 2.54-cm-diameter aperture, at different points over the muscle cross-section area. The apparatus was standardized using black and white standard plates. Prior to the measurement, samples wrapped in oxygen-permeable and water-impermeable