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SHORT COMMUNICATION

A note on meat quality traits of pheasants (*Phasianus colchicus*)

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Abstract Meat yield, proximate composition, pH and drip loss of breast and thigh muscles were studied in 29 hunted male and 32 slaughtered female pheasants. In the breast muscles of additional 14 hunted male pheasants, colour, cooking loss and shear force were measured. Weight of muscles of hunted male pheasants was higher than that of slaughtered females, but the percentages of breast and thigh muscles relative to the dressed carcass did not differ. Average protein concentrations in lean muscles were above 22%, and average fat was below 1.2%. In breast muscles, pH_{24} was lower than in thigh (ca. 5.6 vs. 6.0), and, consequently, drip loss was higher (2.2-3.0% vs. 1.0-1.5%). Colour of breast muscles was characterised by L*a*b* values of about 55, 4 and 8-9, respectively. The shear force of breast muscles was about 30 N/cm^2.

Keywords Pheasant meat · Proximate composition · Drip loss · pH · Cooking loss · Colour

Introduction

Meat from wild-living game is a highly valued food. Recent studies have dealt with hygiene and food safety implications of the production of meat from game birds, with respect to "Good Hygiene Practice" (Paulsen et al. 2008; El-Ghareeb et al. 2009). However, also sensory quality traits have to be considered, because they will substantially influence the consumers attitude to select and buy such meat or products thereof. Basically, colour/appearance, tenderness, juiciness and flavour/odour are the most important sensory attributes for consumers regarding meat (Smulders et al. 1991; Risvik 1994). Among those, colour and drip loss (water-holding capacity; related to juiciness) are the first and more prolonged sensations among the aforementioned sensory quality characteristics (Lawrie and Ledward 2006). This view has been corroborated by consumer behavioural science (Becker 2000). In particular, water-holding capacity has several implications for shelf life of fresh meat as well as for processing technology (Hofmann 2004), and is influenced by other factors, as pH (Lawrie and Ledward 2006).

Pheasants contribute substantially to the hunting bags in European countries, e.g. 79% of ca. 19 million game birds shot in 2004 in the UK (PACEC 2006), with significant benefits for local economy. Even in small countries, pheasants are among the most relevant small game species, e.g. 61% of a total of ca. 265,000 hunted game birds in Austria in 2008 (Anonymous 2010). Hunted pheasants are either wild-born feral or were bred in aviaries and then released. Farming of pheasants is done not only for restocking/release in hunting but also for slaughter and meat production (Golze 2010).

A number of studies have reported the meat yield and proximate chemical composition of meat from pheasants (Petkov 1984; Richter et al. 1992; Tucak et al. 2008). Although these data are valuable to characterise the nutritional quality of meat, they will affect the consumers attitude only to a limited extent ("credential quality cues" according to Becker 2000). For fresh meat, it is conceivable that sensory perceptions will "override" those credential

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quality cues. Comparatively few studies have dealt with instrumental measurement of sensory quality of pheasant meat (e.g. Richter et al. 1992; Kuzniacka et al. 2007). Until recently, the lack of harmonisation in methodology (Honikel 1998) made comparisons of results to other studies on the same or other species difficult or impossible.

The present study was, therefore, conducted to determine chemical and physical indicators for colour, tenderness and juiciness as important factors for sensory meat quality (Smulders et al. 1991; Risvik 1994) according to the protocols proposed by Honikel (1998). Also, the yield of the highly valued meat portions from pheasants (breast and thigh) and edible by-products was determined. Hunted (shot) pheasants were included in this study as well as slaughtered pheasants.

Materials and methods

Hunted animals (n=43, all male) were collected from three drive hunts in Lower Austria in autumn/winter where they had been killed by lead shots of 2.5-3 mm diameter. Slaughtered specimens (n=32, all female) were randomly picked from two batches of animals which had been slaughtered in a pheasantry in the Czech Republic (i.e. animals were stunned by a blow on the occipital region of the head and killed by subsequent bleeding under the provisions of Council Directive 93/119/EC (1993)). Carcasses were delivered in uneviscerated condition. All specimens were cooled to 0-2°C internal temperature within 12 h post mortem (p.m.).

Meat yield

Meat yield was determined in 29 carcasses of hunted male and 32 carcasses of slaughtered female pheasants. Animals were eviscerated 24 h p.m., and processed as described earlier (El-Ghareeb et al. 2009). Weight of dressed carcass (i.e. eviscerated carcass; wings, distal legs, neck, head, crop, feathers and skin removed) and edible by-products was recorded.

Physical characteristics

From 29 carcasses of hunted male and 32 carcasses of slaughtered female pheasants, the right breast muscle (M. pectoralis superficialis) and right thigh were removed 24 h p.m. Measurement of pH was done in the breast muscle and in the M. iliotibialis lateralis (Testo 230; Testo Lenzkirch, Germany). Left breast and thigh were packed in a plastic bag (PA/PE film, 90 µm thickness) and stored for 7 days at 0-2°C for determination of drip loss. Breast and all thigh muscles were used for chemical analysis further on.

Due to the limited size of the muscles, colour, cooking loss and shear force measurements had to be done in breast muscles of separate 14 hunted male pheasants. Right breast muscles were removed from the carcass and tested 24 h p.m., and left breast muscles were removed at 96 h p.m. (storage at 0-2°C). Colour (L*a*b* values) was measured at the muscle surface with a Phyma Codec 400 (Phymacom, Giesshübl, Austria). The mean value of three measurements was recorded. For cooking loss, muscles were weighed, put into plastic bags and heated in a water bath set at 72°C until a core temperature of 70°C was reached. Then, the bags were cooled under running tap water, the meat taken out, gently wiped dry and re-weighed. Cooking loss was calculated as the percentage of weight loss of the meat cut. For shear force (tenderness) measurement, the cooked meat was cut into longitudinal samples with a quadratic cross section of 1 cm^2. These primatic samples were tested with an Instron 4411 with attached Warner-Bratzler device. The shear blade was 1.2 mm thick and had a rectangular hole (width: 11 mm; height: 15 mm), crosshead speed was 100 mm/min. Per muscle, three subsamples were tested and the mean value of three measurements was recorded.

Chemical analysis

Visible fat and tendons were removed from the meat cuts. Samples were ground and dry matter, crude protein, fat and ash were determined according to the German standards method book (Amtliche Sammlung von Untersuchungsverfahren nach §64 LFBG: L 06.00-3, 2004; L 06.00-7, 2007; L 06.00-6, 1980; L06.00-4, 2007, respectively).

Statistical analysis

Data are presented as ranges or arithmetic mean ± standard deviation. Traits of breast vs. thigh muscle (separately for hunted males and slaughtered females) and colour/cooking loss/shear force of breast muscle only at 24 vs. 96 h p.m. were compared by Student's t test (SPSS V.14.0, Chicago, USA). Traits of hunted males vs. slaughtered females were not compared.

Results and discussion

Limitations of the data set

All hunted (shot) animals were male, whereas all slaughtered ones were female. This reflected the usual procedure in that particular pheasantry, but also complicates a comparison between these two groups as any difference between the two study groups could be effected by sex, age, feeding, rearing and mode of killing or a combination

Table 1 Physical and chemical characteristics of breast and thigh muscles from pheasants (mean ± SD)

	Hunted male pheasants (n=29)		Slaughtered female pheasants (n=32)	
	Breast	Thigh[c]	Breast	Thigh[c]
Moisture[d]	71.83±1.11a	75.28±1.03a	71.85±1.81	74.20±0.70
Crude protein[d]	25.66±1.27a	22.60±2.03a	25.03±1.08b	23.56±0.42b
Fat[d]	0.35±0.25a	1.16±0.55a	0.52±0.20	0.84±1.05
Ash[d]	1.39±0.15	1.32±0.08	1.30±0.05b	1.39±0.03b
pH_{24}	5.66±0.08a	6.03±0.20a	5.55±0.16b	5.93±0.25b
Drip loss[e]	3.03±0.57a	1.49±0.36a	2.19±1.37b	1.00±0.56b

a,*b* within row and within group (hunted male or slaughtered female), a common letter indicates a significant (p<0.05) difference between breast and thigh

[c] Data refer to a mix of all thigh muscles for chemical composition and drip loss, and to the M. iliotibialis lateralis for pH

[d] g/100 g

[e] Drip loss within 7 days at 0-2°C, g/100 g

of these factors. Also, due to the small sizes of muscles, not all of the analyses described below could be done in all animals.

Meat yield

Weights of the male hunted birds (whole bird) were 1336.7± 119.4 g, and those of female slaughtered pheasants were 912.5±142.1 g. These data agree well with other reports, e.g. average weights of 1232±147 g for hunted-males (Tucak et al. 2008) and 907±90 g (Richter et al. 1992) or 970±157 g (Tucak et al. 2008) for slaughtered females.

As in other gallinaceous game birds (e.g. chukar partridge, Özek et al. 2003), female pheasants have a 15-40% lower body weight than males of the same age and keeping condition (farm/aviary or free range), see Richter et al. (1992), Tucak et al. (2008) and Golze (2010). Also breed, age, feeding regime and keeping condition can have a substantial influence on body weight (Tucak et al. 2008; Golze 2010).

Weights of dressed carcasses were 875.4±86.6 and 555.3±88.8 g for hunted male and slaughtered female pheasants, respectively, or 65.5±1.8 and 60.9±3.7% of the weight of the whole birds. This is somewhat lower than the yields reported by Richter et al. (1992), with 67.7% and 64.5 % and Golze (2010), with ca. 66-68% (cold carcass weight, sex not specified).

Edible viscera (gizzard, heart, liver), breast and thigh muscles amounted up to 75.0±9.9, 270.8±27.7, 264.0± 22.4 g, respectively, for hunted male birds, and were higher in weight than those of slaughtered females (70.4±8.5, 169.2±28.7, 166.8±23.9 g). These data agree well with those reported by Tucak et al. (2008) and Richter et al. (1992). However, weight of the major muscles (breast and thigh muscles) related to the weight of the dressed carcass in hunted male vs. slaughtered female pheasants was similar (61.2±2.8 vs. 61.5±2.5%). A number of studies indicate that sex has no influence on the percentage of muscle weight to carcass weight (Kuzniacka et al. 2007; Tucak et al. 2008; Golze 2010), whereas the origin of the animals (free range vs. pheasantry) will affect the relation breast to leg muscles (Golze 2010).

Chemical composition of muscles

In both study groups, protein concentrations in breast muscle were significantly higher than in thigh muscles (Table 1), similar to the findings reported by Tucak et al.

Table 2 Selected physical characteristics of breast muscles from hunted male pheasants (n=14), as assessed 24 and 96 h post mortem (p.m.) (mean ± SD)

	Lightness L*[a]	Redness a*	Yellowness b*[a]	Cooking loss (g/100g)	Shear force (N/cm^2)
24 h p.m.	54.2±4.5	3.8±1.9	8.0±1.2	11.5±4.9	28.9±13.0
96 h p.m.	56.6±3.5	4.0±1.4	9.2±1.2	12.6±1.8	31.8±11.2

[a] Indicates that results for 24 and 96 h p.m. differ significantly, p<0.05

(2008). Higher protein contents were associated with lower contents of moisture and fat. Several studies indicate that the protein content of meat from male and female pheasants will not differ (Kuzniacka et al. 2007; Tucak et al. 2008: Golze 2010), but that gross composition of wild and farmed pheasant may differ (Tucak et al. 2008). Data on fat content depend on the mode of dressing. For lean breast muscle, Tucak et al. (2008) and Golze (2010) reported 0.6-1% fat. Average ash concentration was in the range of 1.30-1.40%, and only slightly higher than that reported in literature (ca. 1.1 and 1.2%; Tucak et al. 2008; and Richter et al. 1992). In summary, our data agree well with those reported from other geographical areas.

Physical indicators

In both study groups, pH measured 24 h p.m. was ca. 0.4 units higher in thigh than in breast muscles, which is in accordance with previous studies (Richter et al. 1992; Kuzniacka et al. 2007; Paulsen et al. 2008). A different pattern of myofibres in the studied muscles can account for that: breast muscles of pheasants are predominantly (>70%) composed of fast-twich, glycolytic fibres (IIB type), whereas thigh muscles have higher percentages of other, glycolytic-oxidative (IIA) or oxidative fibre types (Kiessling 1977). This difference is common for gallinaceous birds, and reflects the ability for rapid take-off, at the expense of short flight distances (Pyörnilä et al. 1998). Also, ante mortem stress can have an influence, especially in muscles rich in IIB fibres (Lawrie and Ledward 2006), but in view on the cited studies on pheasants, it is not clear how to weigh stress caused by drive-hunting vs. that due to ante mortem manipulation and slaughter.

As can be expected, drip loss was higher in the muscles with lower pH (Hofmann 2004).

An average shear force of 30 N/cm^2 in the breast muscle of pheasant (Table 2) is similar to that reported for broiler and turkey breast (Werner et al. 2009), but due to subtle differences in methodology, this comparison must be done with caution. No reference on instrumental measurement of pheasant meat could be found, but there are reports on assessment of tenderness by tester panels (Golze 2010). For other wildlife species, as roe deer and chamois, and using an identical methodology, similar shear force values were reported by Winkelmayer et al. (2004) and Hofbauer et al. (2006).

Colour of the breast muscles (Table 2) was characterised by an average lightness (L*) of 54.2, which increased to 56.6. L* values in the range of 51-60 have also been reported by other authors for pheasant (Golze 2010) and chicken (Werner et al. 2009), whereas Kuzniacka et al. (2007) report for pheasant lower L* values of 43-47.

Averages for redness (a*) and yellowness (b*) in stored breast muscles were 4.0 and 9.2, respectively. Our data are quite similar to a* and b* values of 2.98 and 6.65 for the M. pectoralis superficialis of broilers (Werner et al. 2009), which also is dominated by IIB fibres (Barnard et al. 1982). Quite different results are reported for this muscle in 12-20-week-old pheasants by Kuzniacka et al. (2007), with a* and b* values of 14-15 and 1-2.5, respectively. As the methodology of measurement is not well described, differences in sample preparation of meat (measurement on surface or of a meat cut, fresh or stored meat) could account for this. Also, the concentration of heme pigments and their oxidative status have to be considered when evaluating L*a*b* values of muscles (Mancini and Hunt 2005).

When comparing results obtained 24 and 96 h p.m., an increase of lightness and yellowness was observed, similar to results reported for broiler and turkey by Werner et al. (2009).

Breast muscles from pheasants clearly differ in their colour from muscles of wild ruminants, which are darker and have a higher red component, e.g. roe deer and chamois are characterised by L* values in the range of 35-45, a* values of 15-16 and b* values of 11 (Winkelmayer et al. 2004; Hofbauer et al. 2006). Again, this can be explained by the dominance of "white" IIB fibres, which is associated with higher L* and lower a* values (Lawrie and Ledward 2006).

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