Arch Lebensmittelhyg 68,
56–61 (2017)
DOI 10.2376/0003-925X-68-56

ISSN 0003-925X

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Quantity and quality properties of breast and thigh of chicken broilers from organic and conventional production systems

Qualitative und quantitative Eigenschaften von Hühnerbrüsten und -oberschenkeln aus ökologischer und konventioneller Erzeugung

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Summary

The aim of the present study was to investigate qualitative and quantitative properties of breast and thigh (muscle and skin) of chickens from organic and conventional production systems, currently provided in markets for Czech consumers. Production properties (yield and weight), sensorial attributes, surface colour (lightness /L*/, redness /a*/, yellowness /b*/), texture of muscle (raw and baked) and chemical indicators (dry matter/moisture, total protein, net protein, collagen, hydroxyproline, fat and ash) in fresh chicken broilers were evaluated. The conventional chickens had heavier ($P < 0.01$) breasts than organic chicken. The colour indicators showed that the skin of organic chickens (breast and thigh) was more yellow, contrary to less yellow muscles. The thigh of organic chickens (raw and baked) was less ($P < 0.05$) tender than conventional broiler thighs. The total protein content of organic breast muscle was greater ($P < 0.05$) but fat content in organic chicken breast was lower ($P < 0.01$) than in conventional broiler breasts. Our results indicate that the quality of organic chicken meat was slightly superior to conventional chicken meat whereas the yields of eviscerated carcass and breasts were inferior.

Keywords: chicken meat, texture, colour, sensorial attributes, chemical parameters

Zusammenfassung

Ziel der vorliegenden Studie war es, qualitative und quantitative Eigenschaften von Brust und Oberschenkel (Muskel und Haut) von Hühnern aus ökologischen und konventionellen Produktionssystemen zu untersuchen und zu vergleichen. Untersucht wurde Fleisch vom tschechischen Markt. Ausgewertet wurden folgende Eigenschaften: Produktionseigenschaften (Ausbeute und Gewicht), sensorische Attribute, Oberflächenfarbe (Helligkeit /L */, Rötung /a */, Gelbwert /b *), Textur des Muskels (roh und gegart) und chemische Indikatoren (Trockenmasse / Feuchtigkeit, Gesamtprotein, Netto-Proteinverwertung, Kollagen, Hydroxyprolin, Fett und Asche). Die Hühner aus der konventionellen Produktion hatten eine schwerere ($P < 0.01$) Brustmuskulatur ($P < 0.01$) als die Tiere aus der ökologischen Haltung. Die Farbindikatoren zeigten, dass die Haut von Bio-Hühnern (Brust und Oberschenkel) gelber waren. Die Oberschenkel der organischen Hühner (roh und gebacken) waren weniger ($P < 0.05$) zart als die der Broiler aus der herkömmlichen Haltung. Das Gesamtprotein der organischen Brustmuskeln war größer ($P < 0.05$), der Fettgehalt aber niedriger ($P < 0.01$) als bei den herkömmlichen Tieren. Unsere Ergebnisse deuten darauf hin, dass die Qualität des Bio-Hühnerfleischs etwas besser als des herkömmlichen Hühnerfleischs war, während die Mengeneigenschaften schlechter waren.

Schlüsselwörter: Geflügelfleisch, Haut, Textur, Farbe, Eiweiß

Introduction

Czech organic food market is described as developed in comparison with other Central European and Eastern European countries. Despite the economic challenges of organic food in the Czech Republic, consumption of organic food is rising (Zivelova and Crhova, 2013). About 117 tons of poultry meat from organic rearing systems has been produced in the Czech Republic during 2015 (Hrabalová, 2016). The conditions of organic production system include: higher level of animal welfare (access to free-range area, preferably pasture, stocking densities), use of suitable breeds and strains (slow-growing) and feeding with organic feed that meets the animal's nutritional requirements (growth promoters, synthetic amino-acids and GMO are not permitted) (Regulation (EC) No 889/2008). Organic products have gained popularity among consumers but there is a little evidence to support consumers' perceptions about higher quality and safety of organic chicken meat reared with high standards of animal welfare (Napolitano et al., 2013). Indeed, inconsistent data have been published on the effects of organic and free-range system on the qualities and quantities (yield of valuable cuts) properties of poultry meat (Husak et al., 2008; Wang et al., 2009; Fanatico et al., 2009; Dou et al., 2009; Poltowicz and Doktor, 2011; Küçükyilm et al., 2012; Dal Bosco et al., 2014; Abdullah and Buchtova, 2016; Li et al., 2017).

Many factors influence the quality and quantities parameters of organic and conventional broilers such as e. g. genotype (slow- or fast-growing), slaughtering age (maturity) stocking density (indoor/outdoor), nutrition, sex, season as well as production methods (organic/conventional) (Fanatico et al., 2007; Ponte et al., 2008; Dal Bosco et al., 2014). The purpose of the study can be overviewed by the fact that organically produced chicken meat are by default more expensive than conventionally produced meat, and there is a neediness for quality superiority justification of chicken meat produced organically (Husak et al., 2008). The consumers should receive objective information about quality parameters of chicken meat from organic system which is offered in retail markets. The objective of this study was to evaluate the quality and yields of breast and thigh (muscle/skin) of broilers from organic and conventional production systems as they are currently sold in retail markets.

Material and Methods

Production properties

Total of 15 organic broiler chicken (OC) carcasses were obtained directly from organic farms (Biopark s.r.o., Lipova, Czech Republic) meeting requirements laid down in commission regulation (EC) No. 889/2008), and 20 conventional broiler chicken (CC) were obtained from conventional producer (Vodnanska drubez, a.s., Vodnany, Czech Republic) meeting requirements of safety and product quality depending on the Regulations (EC) Nos. 852/2004 and 853/2004. The rearing conditions were as follows: 1) organic birds – Color yield genotype, this slow-growing broiler was developed for France's famous *Label Rouge* organic free-range chickens and adopted by some producers in the United States (Damerow, 2012), slaughtering age 81 days, stocking density 10 birds/m^2, access to free range area during summer period, live weight 2379 ± 384.80 g; 2) conventional birds – Ross 308 genotype, slaughtering age 38 days, stocking density 18 birds/m^2, no access to free range area, live weight 2284 ± 235.51 g.

Slaughtering and processing of birds were done by producers (organic and conventional) according to Regulations (EC) Nos. 1099/2009 and 853/2004. The samples (cold ready-to-cook-carcass) were transported from both producer farms to Department of Meat Hygiene and Technology of the Faculty of Veterinary Hygiene and Ecology, University of Veterinary and Pharmaceutical Sciences Brno (Czech Republic) and stored in a refrigerator with controlled temperature (+2 ± 2 °C) until analysis. Dissection of the carcasses was done in compliance with council regulation (EC) No. 543/2008. The eviscerated carcass (without neck, feet and guts), breasts (with and without skin), thighs with bone (with and without skin) and right thigh muscles (without bone and skin) were weighed and yields were calculated according to decree No. 471/2000 Collection of laws. Yield measurement: yields of whole eviscerated carcass, breasts (with and without skin), thighs with bone (with and without skin) and right thigh muscles (without bone and skin) were calculated by the formula: yield (%) = (weight of the aforementioned carcass cut / live weight) × 100.

Colour indicators

The colour indicators (lightness /L*/; redness /a*/; yellowness /b*/) of raw surface (skin and muscle) of breasts and thighs (left and right) were measured according to the CIE L*a*b* system by using Minolta CM 2600d (Konica Minolta, Japan). Software (Spectra Magic 3.61) was used for calculation the variables and the mean ± standard deviation (SD) of five measurements for each sample was reported.

Sensorial attributes

Consumer panellists were recruited from the DMHT for sensory assessment of breasts and thighs of OC and CC, separately. Samples of breasts and thighs were evaluated raw and after heat treatment (baked in aluminium foil at 220 ºC/40 min) in oven (Garbin 23 GM UMI, Italy). The panellists were asked to evaluate the sensorial attributes of the raw breast and thigh meat including their overall acceptability; colour; odour; consistency and juiciness after a slight compression, whereas in case of baked samples, the following sensorial attributes were evaluated: overall acceptability; odour; consistency; juiciness and flavour. The test was carried out using non-structured 100-mm hedonic scales. Mean value of sensorial evaluation was calculated as average of all five aforementioned sensorial attributes.

Texture indicators

Instron Universal Testing Machine (model 5544) (Instron Corporation, United Kingdom) was used in order to test breasts and thighs of chicken by Warner-Bratzler test. Computer software (Merlin, Series IX) was used to obtain the indicators. Warner-Bratzler test was used to measure the shear force and toughness of baked and raw samples of breasts and thighs (1.0 cm wide, 1.0 cm high and 2.0 cm long), with crosshead speed 80 mm/min. The result *(shear force in Newton N, toughness in kilopascal kPa)* of each sample was given as mean ± standard deviation (SD) of five measurements.

Chemical analysis

The basic chemical composition indicators of raw breasts and deboned thighs from OC and CC were evaluated. The samples of chickens, i. e. breast and thigh muscles, breast and thigh skin were homogenised. The amount of dry matter/moisture was determined gravimetrically by drying of samples for 24 h at +103 ± 2 °C (CSN ISO 1442:1997). The content of total protein was determined by using Kjeltec 2300 analyser (FOSS Analytical AB, Höganäs, Swe-

Journal of Food Safety and Food Quality 68, Heft 3 (2017), Seiten 53–80

den) based on the amount of organically bound nitrogen (recalculating coefficient f = 6.25) according to CSN ISO 937:1978, net protein content was indicated as the amount of nitrogen that organically bound using Kjeltec 2300 (FOSS Analytical AB, Högänas, Sweden) after precipitation with hot tannin solution (SOP: 2000). The collagen content was computed (coefficient factor f = 8) from the content of the amino acid hydroxyproline (SOP: 2000). The quantity of hydroxyproline was indicated by photometric measurement of absorbance at 550 nm on a GENESYSTM6 (Thermo Electron Corporation, USA) spectrophotometer (SOP: 2000). The fat content was analysed on the SOXTEC 2055 (FOSS Analytical AB, Högänas, Sweden) with petrol ether as extraction agent (CSN ISO 1443: 1973). Ash was detected gravimetrically by burning the sample at 550 °C until black carbon particles disappeared in muffle oven (Elektro LM 212.11, Germany) according to CSN ISO 936: 1978.

Statistical data analyses were conducted by using Microsoft Office Excel 2003. Student's *t*-test was used to assess the differences between OC and CC samples. The 0.05 and 0.01 levels of significance were used.

Results

The results are shown in Table 1–5. It is important to indicate that no statistical differences were found between the live weight of organic and conventional broilers in this study. Eviscerated carcass and breasts with/without skin of CC yielded more than carcass and breasts of OC. The results indicated that the breasts of CC (with and without skin) were heavier than breasts of OC (Table 1).

There were no differences observed in colour indicators between left and right breasts and thighs (data not shown). The muscle colour of breast and thigh from OC was less yellow (b*) than colour of CC. In contrary, skin colour of OC was more yellow (b*) than colour of CC. In comparison with conventional broilers, the skin colour of organic breast was darker (L) and muscle colour of organic thigh was lighter (L). Skin of organic breast was less red (a*) than skin of conventional broilers, no difference was observed between organic and conventional samples (skin of thigh, muscle of breast and muscle of thigh) in redness parameter (a*) (Table 2).

No statistical difference for sensorial attributes was found between OC and CC raw breast and breasts after heat treatment (baked). In raw meat the mean value of sensorial evaluation of breasts and thighs from CC was higher (no significance) in comparison with meat from OC hybrids. After heat treatment the same sensorial parameter was higher for organic chickens (Table 3).

OC thighs (raw and baked) were less tender, requiring more shear force, than CC thighs (raw and baked).

TABLE 1: *Production properties for organic chickens (OC) and conventional chickens (CC).*

carcass part	yield of carcass portion in %			weight of carcass portion in g		
	OC n = 15 mean ± SD	CC n = 20 mean ± SD	Stat. sign.	OC n = 15 mean ± SD	CC n = 20 mean ± SD	Stat. sign.
whole alive chicken	–	–	–	*2379.00 ± 384.80*	*2284.00 ± 235.51*	NS
eviscerated carcass	*69.22 ± 2.10*[a]	*73.12 ± 1.54*[b]	**	*1630.36 ± 274.81*	*1671.86 ± 182.43*	NS
breast with skin	16.26 ± 1.53[a]	23.53 ± 4.10[b]	**	385.41 ± 85.66[a]	518.82 ± 77.10[b]	**
breast muscle[1]	14.74 ± 1.38[a]	22.02 ± 3.75[b]	**	349.22 ± 76.67[a]	486.04 ± 74.45[b]	**
thigh with skin	21.42 ± 2.20	22.23 ± 3.37	NS	506.08 ± 108.22	488.57 ± 46.45	NS
thigh muscle[1]	19.75 ± 1.06	19.43 ± 0.69	NS	465.54 ± 86.16	445.38 ± 44.86	NS
thigh (pure meat)	7.29 ± 0.62	7.05 ± 0.28	NS	172.01 ± 35.19	174.45 ± 14.90	NS

[1]: without skin, Stat. sign.: Statistical significance, values in the same row with different letters [a, b] are significantly different **P < 0.01, NS: No significance. Data write in *italic* was published in Veterinarni Medicina (Abdullah and Buchtova, 2016)

TABLE 2: *Colour variables (L*, a*, b*) for raw breasts and thigh of organic chickens (OC) and conventional chickens (CC).*

carcass part	type	L* mean ± SD	Stat. sign.	a* mean ± SD	Stat. sign.	b* mean ± SD	Stat. sign.
skin of breast	OC	67.88 ± 3.65[a]	**	1.19 ± 1.69	**	12.95 ± 3.45[b]	*
	CC	71.15 ± 2.38[b]		2.16 ± 1.24		11.60 ± 1.46[a]	
muscles of breast	OC	*57.63 ± 2.36*	NS	*–0.57 ± 0.65*	NS	*6.68 ± 1.34*[a]	**
	CC	*58.04 ± 2.57*		*–0.30 ± 0.87*		*8.15 ± 1.33*[b]	
skin of thigh	OC	68.73 ± 2.88	NS	2.03 ± 1.41	NS	12.95 ± 2.29[b]	**
	CC	68.65 ± 2.01		1.79 ± 0.88		8.05 ± 1.93[a]	
muscles of thigh	OC	59.01 ± 2.35[b]	*	2.36 ± 1.20	NS	5.45 ± 1.28[a]	**
	CC	54.48 ± 2.74[a]		2.10 ± 1.02		6.57 ± 1.39[b]	

Stat. sign.: Statistical significance, values in the same column with different letters [a, b] between two groups (e. g. skin of breast from OC / CC) are significantly different *P < 0.05, **P < 0.01, NS: No significance. Data write in *italic* was published in Folia Veterinaria (Abdullah and Buchtova, 2015)

TABLE 3: *Sensorial attributes of breast and thigh in raw status and after heat treatment (220 ºC/40 min) from organic chickens (OC) and conventional chickens (CC).*

parameters	OC mean ± SD	CC mean ± SD	Stat. sign.	OC mean ± SD	CC mean ± SD	Stat. sign.
	breast in raw status			thigh in raw status		
overall accep.[1]	*86.90 ± 9.50*	*86.62 ± 12.40*	NS	78.88 ± 14.62	82.14 ± 17.21	NS
color	*88.33 ± 10.50*	*86.86 ± 11.64*	NS	81.94 ± 9.82	86.28 ± 12.13	NS
odor	*86.88 ± 15.75*	*89.34 ± 10.89*	NS	88.59 ± 12.05	90.10 ± 9.29	NS
consistency	*69.50 ± 32.60*	*78.42 ± 23.63*	NS	79.00 ± 24.12	76.80 ± 23.72	NS
juices[2]	*89.65 ± 11.24*	*93.48 ± 5.67*	NS	89.13 ± 10.37	93.40 ± 10.06	NS
mean value[3]	84.25 ± 18.31	86.94 ± 14.39	NS	83.51 ± 15.71	85.74 ± 15.88	NS
	breast after heat treatment			thigh after heat treatment		
overall accep.[1]	*90.65 ± 9.69*	*84.98 ± 12.68*	NS	86.50 ± 11.83	88.52 ± 10.03	NS
odor	*90.15 ± 9.31*	*88.68 ± 7.15*	NS	89.44 ± 9.97	85.88 ± 15.91	NS
consistency	*76.10 ± 22.59*	*79.70 ± 18.81*	NS	69.83 ± 28.15	65.74 ± 23.06	NS
juiciness	*71.02 ± 34.59*	*69.70 ± 26.35*	NS	80.00 ± 18.17	80.96 ± 14.82	NS
flavor	*92.23 ± 6.97*	*88.48 ± 10.39*	NS	87.97 ± 8.23	84.15 ± 10.27	NS
mean value[3]	84.03 ± 20.67	82.31 ± 17.70	NS	83.22 ± 17.97	82.10 ± 18.05	NS

[1]: overall acceptability, [2]: juices release after a slight compression, [3]: mean value of sensorial evaluation, Stat. sign.: Statistical significance, NS: No significance; Data write in *italic* was published in Folia Veterinaria (Abdullah and Buchtova, 2015)

The toughness value of CC breasts was higher than OC (Table 4).

Breast muscles from OC had higher total protein content in comparison with CC, but no significant difference was found between thigh muscles. The net protein in the organic breast and thigh muscle was higher than in CC. The fat content in breast muscle of OC was lesser than in breast muscle from CC. Dry matter in the thighs of OC was higher in comparison with CC thighs (Table 5).

TABLE 4: *Texture analysis of breast and thigh in raw status and after heat treatment (baked at 220 °C/25 min) (shear force in Newton, toughness in KPa) from organic chickens (OC) and conventional chickens (CC).*

parameters		shear force OC mean ± SD	shear force CC mean ± SD	Stat. sign.	toughness OC mean ± SD	toughness CC mean ± SD	Stat. sign.
raw	breast	*27.79 ± 4.97*	*29.43 ± 5.54*	NS	*190.18 ± 20.41*^{a}	*330.33 ± 54.37*^{b}	**
	thigh	79.22 ± 36.13^{b}	53.70 ± 17.61^{a}	*	285.43 ± 74.13	275.67 ± 50.93	NS
baked	breast	*26.42 ± 3.28*^{a}	*33.66 ± 4.84*^{b}	*	*269.68 ± 39.80*^{a}	*394.02 ± 39.35*^{b}	**
	thigh	21.23 ± 5.85^{b}	16.93 ± 3.12^{a}	*	146.33 ± 26.10	197.81 ± 21.12	NS

Stat. sign.: Statistical significance, values in the same row with different letters [a, b] are significantly different *P < 0.05, **P < 0.01, NS: No significance. Data write in *italic* was published in Folia Veterinaria (Abdullah and Buchtova, 2015)

TABLE 5: *Chemical indicators of raw muscle and skin from breasts and thighs of organic chickens (OC) and conventional chickens (CC).*

chemical indicators in %	OC n = 15 mean ± SD	CC n = 20 mean ± SD	Stat. sign.	OC n = 15 mean ± SD	CC n = 20 mean ± SD	Stat. sign.
		meat of breast			meat of thigh	
dry matter	*25.60 ± 0.57*	*25.13 ± 0.72*	NS	28.94 ± 1.48^{b}	27.16 ± 1.32^{a}	**
moisture	*74.40 ± 0.57*	*74.87 ± 0.72*	NS	71.06 ± 1.48^{b}	72.84 ± 1.32^{a}	**
total protein	*23.55 ± 0.46*^{b}	*22.85 ± 1.14*^{a}	*	19.20 ± 0.65	18.71 ± 0.69	NS
net protein	*21.41 ± 0.37*^{a}	*20.43 ± 0.72*^{b}	**	17.46 ± 0.52^{b}	16.63 ± 0.97^{a}	*
collagen	*0.40 ± 0.15*	*0.43 ± 0.03*	NS	1.28 ± 0.30	1.03 ± 0.22	NS
fat	*0.19 ± 0.16*^{a}	*0.58 ± 0.24*^{b}	**	5.71 ± 1.55	5.35 ± 1.92	NS
ash	*1.19 ± 0.09*	*1.15 ± 0.16*	NS	1.03 ± 0.05	1.00 ± 0.03	NS
		skin of breast			skin of thigh	
dry matter	60.40 ± 1.91^{b}	54.84 ± 2.65^{a}	*	59.88 ± 1.10^{b}	50.14 ± 1.67^{a}	**
moisture	39.60 ± 1.91^{b}	45.16 ± 2.65^{a}	*	40.12 ± 1.10^{b}	49.86 ± 1.67^{a}	**
total protein	11.72 ± 0.85	11.62 ± 1.24	NS	14.09 ± 1.41	13.81 ± 0.43	NS
collagen	2.89 ± 0.26	3.17 ± 0.21	NS	4.29 ± 0.10	4.11 ± 0.09	NS
fat	45.15 ± 1.85	38.02 ± 5.17	NS	44.16 ± 0.99^{b}	33.96 ± 1.29^{a}	**
ash	0.58 ± 0.03	0.59 ± 0.06	NS	0.57 ± 0.05	0.59 ± 0.05	NS

Stat. sign.: Statistical significance, values in the same row with different letters [a, b] are significantly different *P < 0.05, **P < 0.01, NS: No significance; Data write in *italic* was published in Folia Veterinaria (Abdullah and Buchtova, 2015)

Discussion

The identical initial live weight of chickens (OC and CC) was our basic condition for meat quality evaluation due to the fact that the study compares two different hybrids of chickens. Higher value of the standard deviation (SD) of live body weight among organic birds was observed. Genotypes with a slower growth capacity are less intensely bred, therefore they show less homogeneity. The whole eviscerated carcass and breast of OC are yielded lower than CC due to slow-growing genotypes of birds that are less efficient to meat production (Fanatico et al., 2009). Broilers have a high methionine requirement to support maximum growth, especially for birds during the growing phase. Non-permitted use of essential amino acids, mainly methionine in organic feed formulation could be negatively reflected on carcass and breast yields (Moritz et al., 2005). However, currently the European Union tries to find alternative methods to produce methionine via enzymatic fermentation based on organic raw materials or the use of insect larvae or algae as a protein source for feed (European Commission, 2014). Conventional broilers are grown to provide the most breast meat yield, probably due to consumers' requests and to provide producers maximum profitability (MacRae et al., 2007). Dal Bosco et al. (2014) confirmed that breast of fast-growing birds grows more than the whole body whereas yields of ready-to-cook carcass and abdominal fat for slow- and medium-growing birds were lower. In contrast Castellini et al. (2002) found that percentages of breast and drumstick are increased whereas amount of abdominal fat is reduced when birds had a lower stocking density and an outdoor access to the open air as in organic production system due to locomotor activity. However, Wang et al. (2009) indicated that free-range raising system significantly reduces growth performance of poultry; it doesn't have an effect on the yields of eviscerated carcasses, breasts and thighs.

Colour represents the first characteristic that is noticed by consumers when buying meat, particularly the colour of skin plays an important role. The results of the study show that the OC breast was darker than the conventional breast. The previous studies (Fanatico et al., 2007; Mikulski et al., 2011) indicated that outdoor access led to reduced L* values of chicken meat. Berri et al. (2001) indicated that breast meat of selected chicken strain for fast-growth was more pale and less red than of non-selected chicken, due to lower level of heme. Normally, heme pigments increase with age (Baeza et al., 2002). Slow-growing birds are usually older than fast-growing, the older broilers have redder meat because of higher content of myoglobin (Gordon and Charles, 2002). However, lesser redness (lower a*) of breast skin from OC was observed in the present study. Fanatico et al. (2005) found that the slow-growing birds were lesser red (lower a*) than the fast-growing chickens. However, Lonergan et al. (2003) explained that different genotypes of birds have different types of muscle fibers leading to differences in redness (a*) value. They found that the breasts of Leghorn inbred line (slow-growing hybrid) were a more intense red colour than the crossbred contemporary. Skin colour is related to ability of birds to produce melanin pigment in dermis and epidermis as well as to carotenoids absorption and deposition (Fletcher, 1999). The more yellow colour of OC (skin) was clearly visible to the naked eye as well as by instrumental means. This more yellow (higher b*) is due to use of organic corn in their nutrition which is not common in conventional production system (Grashorn and Serini, 2006), in addition, more consumption of plant material that contains abundant carotenoid pigments in organic farming (Fanatico et al., 2005). Fresh, dried or ensiled grass can contributed about 10-20% of dietary requirements of birds depending on hybrid and age of bird as well as plant material (Sossidou et al., 2015). Daily rations (at least 60% of dry matter) of organic poultry shall be composed of roughage, fresh or dried fodder, or silage (Regulation (EC) No 889/2008). Also, more yellow colour (higher b*) may be attributable to the skin thickness associated with the higher lipid content (Sirri et al., 2010) as in the present study where the skin of thigh contained higher lipid than skin of conventional poultry thighs (Tables 2, 5). The results of this study indicated that the breast muscles of conventional chicken were more yellow than OC (Tables 2), which could be due to their higher intramuscular lipid content (Table 5, $P < 0.01$) and storage of lipophilic pigments (Sirri et al., 2010).

The results of sensorial attributes indicated that no statistical difference was found between OC organic and CC breast in the raw status and after heat treatment, which is in accordance with the results of Husak et al. (2008). Untrained consumers are not able to distinguish between sensory properties of OC and CC, so that consumer preferences of OC over CC are mostly based on promoting information about organic production system (Napolitano et al., 2013). However, obtained unclear results can be explained by consumers' habit to consume conventional broiler meat whereas organic meat for them is unusual.

The dominating factor affecting meat tenderness is the genotype and age due to different composition of the muscle. Thigh meat from OC broilers is less tender, in agreement with the results found by Husak et al. (2008) and Castellini et al. (2002), who stated that greater locomotor activity of organic poultry affected the tenderness of thigh meat, leading to increased meat shear value. According to Fletcher (2002), at the time of harvest older birds (slow-growing) are more mature and have more cross-linking of collagen and so that have lesser tender meat. Furthermore, the fast-growing birds had more tender breast due to its higher content of intramuscular fat (Le Bihan-Duval, 2003). Diet, pre-slaughter handling and post-slaughter chilling belong among secondary factors affecting texture of meat. Therefore, it is difficult to be attributed to the type of production system only (Husak et al., 2008).

According to many studies (Zerehdaran et al., 2004; Cangar et al., 2006; Rizzi et al., 2007), there are many factors affecting chemical compositions of meat, including genetics, feed rations and physical activity. The higher protein content in organic breast and thigh on one side and lesser fat content in organic breast on another side are supporting the idea that motor activity prefers myogenesis against lipogenesis (Castellini et al., 2002). The consumers prefer light meat (breast) more than dark meat (thigh), so breast meat with lower fat content could be beneficial to consumers concerned with higher fat intake. Generally, the results of present study are corresponding to results of Husak et al. (2008), particularly the higher protein content in breast and thigh of OC (Table 5). The differences in dry matter/moisture content between the two investigated types of birds, particularly in skin samples, (Table 5) may be due to differences in chilling technologies methods (organic – chilling in cold air, conventional – chilling in cold air interspersed with water haze). The surface absorption of water into tissues could occur during chilling process of conventionally produced broiler carcasses (Regulation (EC) No 543/2008). Typically, there is a correlation between body and muscle composition changes with increase of animal age; moisture decreases whereas fat and protein increase (Aberle et al., 2001).

Conclusion

The results of this study reflect the characteristics of chickens originating from organic and conventional systems as marketed to consumer, thus don't necessarily to reflect only the differences of productions systems (organic/conventional) because effect of other factors were not controlled such as feed. The difference of price between OC and CC meat represents one of the most important factors affecting the consumer choice of chicken meat. The main differences were observed in the quantity and quality properties of breast muscles. Higher weight and yield of breasts from conventional chickens could be economically beneficial for producers, but higher protein content and less fat in breasts from organic chickens may be necessary for consumer's health. More skin yellowish colour of organic chicken and other unusual raw sensorial attributes for consumer could affect choice of buyers. Price of organic chicken meat was more than double the price of conventional broiler meat, whereas quality criteria were slightly superior. In order to judge the superiority of organic products, it is necessary to study other aspects that are related to the health of consumers such as antioxidant capacity, content of vitamins and minerals, microbial load and residues or contaminants in the meat.

Acknowledgement

Financial support for this study was provided by the University of Veterinary and Pharmaceutical Sciences Brno, Palackého tr. 1946/1, 612 42 Brno, Czech Republic (Institutional research for year 2014).

Conflict of interest

We declare that no conflict of interest exist in this scientific work.

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