

What is the current quality of cow's meat in Slovakia in comparison with meat of bulls?

Aká je súčasná kvalita kravského mäsa na Slovensku v porovnaní s mäsom býkov?

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Abstract

The present study aimed at comparison of chemical composition, meat quality and sensory parameters of cow's meat and meat from bulls produced under Slovak conditions and sold in retail of Slovakia. The analysis was performed on 181 cows and 78 bulls. Cows were also divided in two groups according to age at slaughter – over ($n = 135$) and/or under 4 years ($n = 46$). The meat samples were taken in eight slaughter houses located in the western, central and eastern part of Slovakia. The age of cows slaughtered had significant effect ($P < 0.05$) on the most meat quality and sensory traits which were evaluated much more worse in older cows with comparison to bulls than in younger cows. Older cows had lower content of proteins and water in meat, lower pH_7 and colour parameter "L" as well as worse evaluation of all sensory parameters in comparison to bulls ($P < 0.05$). On the other hand, intramuscular fat content, energetic value of meat, marbling, pH_{48} , colour parameter "a" and cooking loss were higher in meat of older cows than bulls ($P < 0.05$). Differences in traits observed between younger cows and bulls were statistically significant ($P < 0.05$) only for content of proteins and water, pH_{48} , colour parameter "a", cooking loss and evaluation of odour. The hypothesis of significantly poorer meat and eating quality is justified in the case of cows over 4 years. The study did not confirm the decreasing age of cows at slaughter as suggested previous studies.

Keywords: beef, bulls, cow's meat, meat quality, sensory properties

Abstrakt

Prezentovaná štúdia bola zameraná na porovnanie chemického zloženia, kvalitatívnych a senzorických parametrov mäsa kráv a býkov pochádzajúcich zo slovenských chovov a predávaných v maloobchodnej sieti Slovenska. Analýza bola

vykonaná na 181 kravách a 78 býkoch. Kravy boli rozdelené do dvoch skupín podľa ich veku pri porážke: nad 4 roky ($n = 135$) a do 4 rokov ($n = 46$). Odbery boli vykonané na ôsmich bitúnkoch lokalizovaných na západnom, strednom a východnom Slovensku, aby poskytli čo najreprezentatívnejšiu vzorku. Vek porázaných kráv mal preukazný vplyv ($P < 0,05$) na chemické zloženie mäsa ako aj na väčšinu kvalitatívnych a senzorických ukazovateľov, ktoré boli výrazne horšie hodnotené v skupine starších kráv v porovnaní s býkmi než v skupine mladších kráv. Pre skupinu starších kráv bol charakteristický nižší obsah vody a bielkovín v mäse, nižšie pH_7 , hodnota farby „L“, ako aj nižšie hodnotenie senzorických parametrov mäsa v porovnaní s býkmi ($P < 0,05$). Naopak, obsah intramuskulárneho tuku, energetická hodnota mäsa, mramorovanie, pH_{48} , hodnota farby „a“ a straty grilovaním boli vyššie v mäse starších kráv než v mäse býkov ($P < 0,05$). Rozdiely v chemickom zložení mäsa, v kvalitatívnych a senzorických parametroch medzi mäsom mladších kráv a mäsom býkov boli preukazné ($P < 0,05$) iba v obsahu bielkovín, vody, farby „a“, pH_{48} , stratách grilovaním a vo vône. Hypotéza o preukazne horšej kvalite mäsa a konzumnej kvalite je opodstatnená v prípade kráv starších ako 4 roky. Štúdia taktiež nepotvrdila znižujúci sa vek kráv pri porážke ako bolo zistené v predchádzajúcich štúdiách.

Kľúčové slová: býky, hovädzie mäso, kravské mäso, kvalita mäsa, senzorické vlastnosti

Detailný abstrakt

Na Slovensku v poslednom období narastá podiel kráv na celkovom počte porázaného hovädzieho dobytku. Niektoré štúdie taktiež naznačili klesajúci vek kráv pri porážke. To by mohlo rozšíriť ponuku hovädzieho mäsa v maloobchodnej sieti Slovenska. V spotrebiteľskej verejnosti je však kravské mäso stále považované za menej kvalitné, s horšími senzorickými vlastnosťami než mäso pochádzajúce z býkov. Cieľom štúdie bolo porovnať chemické zloženie, kvalitatívne a senzorické ukazovatele mäsa kráv s mäsom býkov. Za týmto účelom boli odobrané vzorky roštenky (cca 800 – 1000 g) od 181 kráv a 78 býkov. Súbor kráv bol rozdelený do dvoch skupín podľa veku pri porážke, a to kravy staršie ako 4 roky a kravy mladšie ako 4 roky. Odbery boli vykonané na ôsmich bitúnkoch lokalizovaných na západnom, strednom a východnom Slovensku, aby poskytli čo najreprezentatívnejšiu vzorku. Analýzy vzoriek mäsa boli uskutočnené v laboratóriu CVŽV Nitra 48 hodín po zabití. Okrem chemického zloženia boli merané ukazovatele kvality mäsa a senzorická kvalita posúdením náhodnými konzumentmi. Mäso kráv celkovo a kráv starších ako 4 roky sa výrazne líšilo od mäsa býkov vo všetkých chemických ukazovateľoch ($P < 0,05$). Ich mäso malo nižší obsah vody a bielkovín, ale vyšší obsah intramuskulárneho tuku než mäso býkov. Najvyšší obsah vody a najnižší obsah bielkovín bol zistený v mäse mladších kráv. Preukazné rozdiely vo väčšine kvalitatívnych ukazovateľov mäsa boli zistené medzi staršími kravami a býkmi. Staršie kravy mali preukazne tmavšie a červenšie mäso (hodnoty L, a), ale aj výraznejšie mramorovanie, vyššiu elektrickú vodivosť a vyššie straty grilovaním než

býky ($P < 0,05$). Konzumenti prideli všerkým senzorkým ukazovateľom mäsa starších kráv preukazne nižšie hodnoty než mäsu býkov ($P < 0,05$). Naproti tomu rozdiely v chemickom zložení, v kvalitatívnych a senzorkých ukazovateľoch medzi mladšími kravami a býkmi boli oveľa menšie. Mäso mladších kráv malo preukazne vyšší obsah vody, kým mäso býkov malo vyššie zastúpenie bielkovín ($P < 0,05$). Mladšie kravy mali preukazne vyššie pH_{48} , červenšie mäso a nižšie straty grilovaním než býky ($P < 0,05$). Zo senzorkých ukazovateľov bola iba vôňa hodnotená preukazne negatívne v porovnaní s býkmi ($P < 0,05$). Záverom možno konštatovať, že vek kráv pri porážke mal značný vplyv na chemické zloženie, ako aj na kvalitatívne a senzorké ukazovatele mäsa. Rozdiely v porovnaní s mäsom býkov boli významné v prípade starších kráv, zatiaľ čo parametre mladších kráv sa približovali hodnotám zisteným u býkov. Potvrdila sa teda hypotéza o výrazne horšej kvalite mäsa starších kráv v porovnaní s mäsom býkov, predovšetkým z pohľadu jeho akceptácie konzumentmi. Vzrastajúci podiel kráv z celkového počtu porázaného dobytku na Slovensku, ktorý bol potvrdený aj touto štúdiou, môže byť prínosom pre spotrebiteľskú verejnosť iba v prípade nižšieho veku kráv pri porážke (do 4 rokov). Štúdia však nepotvrdila znižujúci sa vek kráv pri porážke ako to bolo zistené v niektorých predchádzajúcich štúdiách.

Introduction

Meat consumption represents one of the main aspects of food chain in human nutrition. Beef production as a traditional type of meat consumed by Slovaks has a long tradition in the Slovak Republic. Despite of all positives that the beef is characterized such as high amount of essential amino acids, vitamins, especially of group B, iron (Steinhauser, 2000; Vojtaššáková et al., 2002; Staruch et al., 2005), its consumption in Slovakia have been decreasing rapidly over the last twenty years (Krejčová et al., 2004; Pomichal, 2008). This condition is caused by several factors – changing eating habits of Slovak population, imbalanced beef quality, insufficient awareness of consumers, world economic crisis but the main factor could be presumably the high retail price due to expensive production costs (Steinhauser, 2000; Šubrt et al, 2006, 2007; Staruch and Fašiangová, 2009). Beef has been becoming a “luxurious” food inaccessible to the most Slovak customers. In recent years, the increasing share of cows from total number of cattle slaughtered in Slovakia was observed (Mojto et al., 2000; Zaujec et al., 2006; Zaujec and Gondeková, 2011). Actually, it is over 50%. The causes of culling of cows are different such as health problems, reproductive disorders, low milk performance, poor nutrition, etc. Since the most of these cows culled is from dairy not beef farms, consumer may doubt the good meat quality. In general, consumers have deeplyrooted idea of the cow's meat as dark, firm and poorer sensory properties in comparison with meat from bulls or heifers. However, compared to past decades there was recently a significant reduction in the age of slaughtered cows in Slovakia (Mojto et al., 2009) which could positively influenced the quality of cow's meat in retail sale. The aim of the study was to verify whether this hypothesis is true, and an idea of the significantly poorer quality of cow's meat compared to meat of bulls is grounded or just a prevailing myth.

Material and Methods

The study was carried out on 181 carcasses of cows and 78 of bulls. The meat samples were taken in eight slaughter houses located in the western, central and eastern part of Slovakia from November 2010 to June 2012. The sampling was done on the loin (800 - 1000 g) between 9th/11th rib from the each carcass within forty-eight hours after slaughter.

Analyses of meat samples were performed in the laboratory of Animal Production Research Centre Nitra 48 hours after slaughter. Chemical composition of meat was determined using device INFRATEC 1265, and energetic value (EV) was calculated subsequently as follows:

$$EV = 16.75 \times \text{proteins \%} + 37.68 \times \text{fat \%}$$

Electrical conductivity (μS) was analysed by device BIOTECH and pH_{48} values were determined by apparatus METTLER TOLEDO with combined electrode. Meat colour was analysed by spectrometry using device MINISCAN XE Plus. Water holding capacity (WHC) was analysed using method of Grau-Hamm modified by Hašek and Palanská (1976). Drip loss of meat was determined by method of Honikel (1986). Marbling of the samples was measured using 10-point scale (USDA, 1997) where 1 – the highest and 10 – no visible intramuscular fat.

Seven days after slaughter, i.e. after ageing of meat, the cooking loss, pH_7 and shear force were determined. Meat samples were wrapped in plastic foils and stored in refrigerator at temperature 4 °C until analysing. Shear force – firmness was measured using device TEXTURE ANALYSER TA-XT2i. Before cooking, 2.0 cm thick slices of *musculus longissimus dorsi* were cutting. After that they were cooking on electric contact grill PM-1015 for 4 min at $t = 200$ °C and cooking loss was determined as difference between weight of meat before and after cooking. Consequently the sensory properties of meat such as odour, taste, juiciness and tenderness were rated using consumer test. Every sample was evaluated by three persons using 5-point scale where 1 – the worst and 5 – the best quality. Data were analysed by statistical package SAS 9.2. Basic statistics was done using MEANS procedure. Whole dataset of cows was also divided in two groups according to age at slaughter: over 4 years ($n = 135$) and ≤ 4 ($n = 46$), resp. All the data are reported as mean \pm standard deviation (sd). The differences between groups were analysed using F-test. The effect was considered significant at a probability of $P \leq 0.05$.

Results and Discussion

As expected, bulls reached the highest slaughter and carcass weight which was significantly different than that of cows total and younger cows (Table 1). That is comparable with results of Méndez et al. (2009) who reported in the survey in Mexico that 71.6% of cattle had slaughter weight in the range between 400 and 500 kg. Lower slaughter weights were presented in other study from Mexico (Martínez et al., 2006) and Costa Rica (ITCR, 2004). Similarly, age at slaughter in our study was significantly different between all experimental groups.

Table 1. Comparison of slaughter and carcass traits
 Tabuľka 1. Porovnanie porážkových a jatočných ukazovateľov

Item	Bulls		Cows		Cows > 4		Cows ≤ 4	
	mean	sd	mean	sd	mean	sd	mean	sd
SW, kg	508.53 ^a	20.72	453.70 ^b	68.55	474.28 ^{ab}	101.80	331.00 ^c	117.72
CW, kg	279.12 ^a	66.21	233.87 ^b	86.88	244.50 ^{ab}	52.47	170.63 ^c	60.65
AS, day	741 ^a	167.84	2682 ^b	278.89	3059 ^c	1222.50	1224 ^d	180.64

a, b, c, d P < 0.05 Legend: SW – slaughter weight, CW – carcass weight, AS – age at slaughter

Chemical composition of meat is shown in Table 2. Bulls had significantly higher content of total water and protein than cows total and cows over 4 years. Younger cows had the highest water content but the lowest protein content. On the other hand, older cows reached significantly higher intramuscular fat content than bulls and younger cows. As known, deposition of intramuscular fat in the muscles is influenced mainly by age and sex of animals. Gondeková et al. (2008) and Mojto et al. (2007) reported lower values of total water (74.80% and 74.12%) and of protein (20.27%) in cows than our study. In another study (Gondeková, 2011) reported higher water content in bulls than cows (76.36 vs. 75.06%) which is in agreement with our study. Higher content of protein in meat of bulls than cows (24.44 vs. 20.35%) was reported in study of Gondeková (2011). Zaujec et al. (2010) found in bulls lower value of protein content (20.85%) while Faucitano et al. (2008) higher (22.00%) than our result. On the contrary, intramuscular fat content of cows in the aforementioned study of Gondeková et al. (2008) was higher (3.90%) than our result. Comparing bulls and cows, Gondeková (2011) observed much more higher intramuscular fat in meat of bulls than cows (3.58 and 1.78%). Mojto et al. (2007) found intramuscular fat content in cows aged 3 - 8 years on the level 4.37% and Vrchlabský (1999) indicates this parameter in musculus semimembranosus of cows even up to the level of 9.41%. On the other hand, Mojto, et al. (2004) reported higher intramuscular fat in bulls than cows. Energetic value in meat of older cows in our study was significantly higher than in bulls and younger cows (487.07 kJ vs. 434.13 and 420.27 kJ).

Table 2. Comparison of chemical composition of meat
 Tabuľka 2. Porovnanie chemického zloženia mäsa

Item	Bulls		Cows		Cows > 4		Cows ≤ 4	
	mean	sd	mean	sd	mean	sd	mean	sd
Total water, %	75.56 ^a	1.82	74.60 ^b	4.00	74.28 ^b	3.54	76.76 ^c	2.61
Total protein, %	21.46 ^a	0.78	20.86 ^b	1.28	20.95 ^b	1.22	19.95 ^c	1.33
IMF, %	1.98 ^a	1.74	3.54 ^b	3.83	3.87 ^b	3.31	2.28 ^a	2.06
EV, kJ*100 g ⁻¹	434.13 ^a	65.28	482.69 ^b	45.54	487.07 ^b	127.09	420.27 ^a	83.83

a, b, c P < 0.05 Legend: IMF – intramuscular fat, EV – energetic value

Important differences between bulls and cows were found in some quality traits of fresh beef (Table 3). The lowest pH₄₈ value was measured in meat of bulls and was significantly different in comparison with cows. Opposite result in favour of bulls (6.11 vs. 5.85) was determined in the study of Gondeková (2011). Significantly lower electrical conductivity in our study was observed in bulls comparing cows total and older.

As expected, cow's meat was darker and redder, especially that of older cows than of bulls. This fact agrees with Gondeková (2011) where L value was lower in meat of cows than that of bulls (29.90 and 30.63). Vrchlabský (1999) found in experiment with bulls, cows, heifers and steers the darkest meat in cows. Similarly, French et al. (2001) and Orellana et al. (2009) observed higher values of meat colour in bulls. On the contrary, Galli et al. (2008), Kim et al. (1998, 2003) reported higher values in cow's meat than beef. Also, older cows had significantly greater marbling than bulls (7.74 vs. 8.50) whereas younger cows did not. Similar results in marbling characterized as "slight, practically devoid" or "traces" have been published by Méndez et al. (2009), Rubio et al. (2007) and McKenna et al. (2002). Significantly higher degree of marbling in cows than bulls was determined by Gondeková (2011): 7.63 vs. 8.58 and Zaujec et al. (2010).

Table 3. Comparison of meat quality 48 h post mortem

Tabuľka 3. Porovnanie kvality mäsa 48 h po zabití

Item	Bulls		Cows		Cows > 4		Cows ≤ 4	
	mean	sd	mean	sd	mean	sd	mean	sd
pH ₄₈	5.59 ^a	0.26	5.73 ^b	0.42	5.70 ^b	0.35	5.88 ^b	0.62
El. conductivity, µS	1.29 ^a	0.96	2.12 ^b	1.48	2.58 ^b	1.00	1.66 ^a	1.19
Colour - L	30.43 ^a	3.00	29.48 ^b	3.59	29.13 ^b	3.55	30.01	4.11
a	10.65 ^a	2.26	11.84 ^b	2.84	11.99 ^b	2.77	11.49 ^b	2.48
b	7.39	1.37	7.27	1.58	7.22	1.54	7.40	1.80
WHC, %	28.13	6.69	28.01	6.88	28.26	7.08	27.06	6.89
Drip loss, %	1.24	0.67	1.26	0.43	1.24	0.44	1.29	0.40
Marbling	8.50 ^a	0.91	7.92 ^b	1.50	7.74 ^b	1.23	8.50 ^a	0.83

a, b P < 0.05

A comparison of quality parameters between groups in 7-days stored beef is shown in Table 4. When taking into account the dataset of cows as a whole there is no significant difference between bulls and cows. However, detailed analysis showed the significantly lowest pH₇ value in older cows in comparison to bulls and younger cows (5.61 vs. 5.79 and 5.87, resp.). Also, older cows had the highest cooking loss. Bulls had lower and younger cows the lowest (29.31 vs. 26.42 and 23.95%). All these differences were statistically significant.

Table 4. Comparison of meat quality after 7-days storage
 Tabuľka 4. Porovnanie kvality mäsa po 7-dňovom skladovaní

Item	Bulls		Cows		Cows > 4		Cows ≤ 4	
	mean	sd	mean	sd	mean	sd	mean	sd
pH ₇	5.79 ^{ab}	0.44	5.69 ^{bc}	0.32	5.61 ^c	0.32	5.87 ^a	0.30
Cooking loss, %	26.42 ^a	7.55	27.20 ^a	7.31	29.31 ^b	7.04	23.95 ^c	8.20
Firmness, W-B	10.34	4.94	10.33	3.90	10.25	3.99	10.51	4.16

a, b, c P < 0.05

Evaluation of sensory properties of beef indicates that taste and odour of meat from bulls were evaluated by the consumers significantly better than meat of cows as whole and older cows. (Table 5). A comparison of tenderness and juiciness did not show significant differences between bulls and cows as a whole. However, detailed analysis revealed again that both parameters were evaluated more negative in meat of older cows than those in bulls. The values of younger cows were between older cows and bulls and differed significantly only in odour comparing bulls. Berriain et al. (2009) evaluated two types of beef in Spain – from yearling Pyrenean bulls and US beef originated from beef cattle slaughtered in EU. Taste of beef from spanish bulls was evaluated worse (3.14 – 3.42) than that of bulls in our study while US beef better (3.46 – 3.67). Similar results were found in tenderness and juiciness while odour of both types of beef was under our value. As our results, in the study of Gondeková (2011) bulls reached better evaluation in all the observed parameters than cows but only differences in odour and tenderness were statistically significant. Also, Cerdeno et al. (2006), and Faucitano et al. (2008) determined better results in bulls than cows. However, Kim and Lee (2003) observed better sensory evaluation in cows than bulls.

Table 5. Comparison of sensory properties
 Tabuľka 5. Porovnanie senzoričských vlastností

Item	Bulls		Cows		Cows > 4		Cows ≤ 4	
	mean	sd	mean	sd	mean	sd	mean	sd
Taste	3.53 ^a	0.67	3.30 ^b	0.75	3.22 ^b	0.73	3.33	0.89
Odour	3.78 ^a	0.61	3.51 ^b	0.73	3.46 ^b	0.69	3.54 ^b	0.94
Tenderness	3.30 ^a	1.07	3.13	0.83	3.02 ^b	0.80	3.19	0.93
Juiciness	3.36 ^a	0.82	3.19	0.72	3.11 ^b	0.64	3.23	0.93

a, b P < 0.05

Generally, older cows (4-years old) had significantly darker and redder meat, higher marbling but also lower pH₇, higher electrical conductivity, cooking loss and worse evaluated all the sensory traits than bulls. On the other hand, the differences

between meat of younger cows (under 4 years) and bulls were much more lesser when cows had significantly redder meat, higher pH₄₈, lower cooking loss and only odour was assessed significantly worse than that of bulls.

Conclusion

The results suggested the increasing share of cow's meat in retail of Slovakia which currently represents over 50%. However, the study did not confirm the decreasing age of cows at slaughter. The proportion of cows under 4 years accounted for only a quarter of the total number of slaughtered cows. When comparing the meat and sensory quality of cows and bulls, it is necessary to take into account the age of cows at slaughter. Hence, the hypothesis of inferior meat and sensory quality of cows is justified in the case of older cows while meat from younger cows approximates a meat of bulls.

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