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Pannon University, Georgikon Faculty of Agriculture, Keszthely, Hungary

SZABOLCS BENE, BARNABÁS NAGY, LAJOS NAGY, BALÁZS KISS,
J. PÉTER POLGÁR and FERENC SZABÓ

Comparison of body measurements of beef cows of different breeds

Abstract

Body measurements of 110 beef cows of 9 breeds (Hungarian Simmental, Hereford, Aberdeen Angus, Red Angus, Lincoln Red, Shaver, Charolais, Limousin and Blonde d'Aquitaine) were taken in December 2004. The absolute, relative measurements and measurement indices moreover correlations between age, live weight and measurements were evaluated and compared for the mentioned breeds. Animals in study were born between 1989 and 2002, kept on the same condition on peat-bog soil pasture at Keszthely.

Significant differences ($P<0.05$) were found among breeds in most of the body measurements. Blonde d' Aquitaine was the heaviest in live weight (638 kg), highest as for the height at withers (142.5 cm), height at rump (146.6 cm) and length of the body (151.5 cm). Limousin had longest measurements as for the length of the rump (47.4 cm) and width of the rump (58.3 cm). Shaver had the longest width between shoulders (52.9 cm) and width of the head (25.1 cm) while Lincoln Red the longest length of the head (52.8 cm).

The correlations between live weight and measurements were medium or strong positive ($r = 0.40 - 0.83$), between age and measurements slight positive ($r = 0.01 - 0.46$), among the different measurements medium or strong positive ($r = 0.22 - 0.81$).

Key Words**:** cow, beef cattle, breeds, body measuremants, body measure indices, correlations

Zusammenfassung

Titel der Arbeit: **Vergleich der Körpermaße von Fleischrindkühen verschiedener Rassen**

Es wurden die absoluten und relativen Körpermaße von 110 Fleischrindkühen von 9 Rassen Ungarisches Fleckvieh, Hereford, Aberdeen Angus, Red Angus, Lincoln Red, Limousin, Charolais, Blonde d'Aquitaine und Shaver verglichen. Die Körpermaße und Gewichte der zwischen 1989 und 2002 geboren Kühe wurden im Dezember 2004 erfasst. Neben den Körpermaßen konnten verschiedene Körpermaßindizes verglichen und die Korrelationskoeffizienten zwischen dem Alter, dem Lebendgewicht und den Körpermaßen berechnet werden. Sämtliche Tiere wurden unter den gleichen Bedingungen auf Moorbodenweiden in Keszthely gehalten.

Zwischen den meisten der verglichenen Rassen konnten bei den Körpermaßen signifikante ($P<0,05$) Unterschiede nachgewiesen werden. Die Tiere der Rasse Blonde d'Aquitaine erreichten das höchste Lebendgewicht und die größte Widerristhöhe, Beckenhöhe und Körperlänge. Die größten Maße für Beckenbreite und Beckenlänge fanden sich bei Limousin, für Widerristbreite und Kopfbreite bei Shaver und für Kopflänge bei Lincoln Red Kühen. Die Korrelationskoeffizienten zwischen dem Lebendgewicht und den Körpermaßen, die bei den drei am stärksten in der Analyse vertretenen Rassen Ungarisches Fleckvieh, Hereford und Angus ermittelt wurden, lagen bei $r = 0,40 - 0,83$, zwischen Alter und Körpermaßen bei $r = 0,01 - 0,46$ und innerhalb der verschiedenen Körpermaße bei $r = 0,22 - 0,81$.

Schlüsselwörter: Kühe, Fleischrinderrassen, Körpermaße, Körpermaßindizes, Korrelationen

Introduction

As in the case of the dairy cattle, it is utterly important to know the body measurements of the beef cattle, too. The body measurement allows us to draw conclusions concerning proportionality and maturity, but it is also in relation to other characteristics (such as live weight). Judging frame size, that is body measurement compared to the average animal measurement of the same breeds, sex and age, is also

based on the measureable body measurements (BREM, 1998); therefore, besides the above uses, body measurements may also serve as important selective considerations.
Based on the conformation, beef production can be better estimated than other production properties. The heritability of the body measurements is relatively high (SZABÓ, 1998; ARANGO et al., 2002a). According to WILSON (1996), heritability of the live weight of the mature animal and of the height at rump is 0.47 - 0.51 and 0.62 - 0.88, respectively, and there is a close (r = 0.80) genetic correlation between the two characteristics.
There are numerous references on the body measurements of the breeds both in the national and the international literature (HORN, 1973; GERE and BARTOSIEWICZ, 1979; HOLLÓ and HORVÁTH, 1979; BALIKA and BODÓ, 1984; NEUMANN et al., 1988; SCHRAMM et al., 1989; WOLLERT et al., 1989; PAPSTEIN et al., 1993; HARTJEN et al., 1993; FELIUS, 1995; HORN, 1995; TŐZSÉR et al., 1995; WILSON, 1996; BAUER et al., 1997; POLGÁR et al., 1997; VAN MARLE-KÖSTER et al., 2000; TŐZSÉR et al., 2000a, 2000b, 2000c, 2001; SAMBRAUS, 2001; ARANGO et al., 2002a,b,c,d, 2004).
WOLLERT et al. (1987) compared body measurements of 4 genotypes in 1st and 3rd calving. The correlation between live weight and height at withers was 0.84, between live weight and height at rump 0.70.
SZABÓ (1990) compared 13 body measurements of Hungarian Simmental x Hereford F_1 bulls and progenies from reciprocal crosses at the end of the fattening. The body measurements of Hungarian Simmental x Hereford F_1 bulls were in numerous cases bigger than those of the reciprocal ones; the difference in wither height was 5.4 cm, in width of chest was 11.1 cm. He found no significant differences in the body measure indices, though.
ENGELHARDT et al. (1992) have examined the correlation of some measured traits with the tissue components, and between shape traits, fat depths and the precentage of kidney and pelvic fat in two breeds (Simmental and German Black Pied Dairy).
Concerning the type forming of beef cattle, several authors (BALIKA, 1990; BODÓ et al., 1997; ARANGO et al., 2004a) point out the fact that in our time the breeders focus on increasing especially the size of the back, the loins and the rump as well as on lengthening the trunk. This breeding intention will in the long run increase the live weight of the mature animal, as well as the wither height (TŐZSÉR et al., 2001).
However new methods, such as photometric MÉSZÁROS (1977), application of video technology BODÓ et al. (1997), KMET et al. (2000), TŐZSÉR et al. (2000c) and KÜHN et al. (2002) are spreading, the traditional measuring tools (measure stich, measuring tape, bow-compasses) are still used for taking body measurements.
It is apparent fom the literature on body measurement that there are very few comparative examinations on the various beef cattle breeds. The published data are mostly from technical books, and refer to animals kept in various palces at various times.
Based on the aforesaid, the aim of the study was to take some body measurements with traditional methods, to compare the body measurements and body measure indices of some beef cattle breeds. The examinations were made possible by the researches in Hungary at Keszthely, where several beef cattle breeds have been under the same circumstances for years.

Material and Methods

Examination of various cattle body measurements were performed based on the data of the beef cattle population at the Georgikon Agricultural Faculty. The research involved 110 cows of nine breeds (Hungarian Simmental, Hereford, Aberdeen Angus, Red Angus, Lincoln Red, Limousin, Charolais, Blonde d'Aquitaine and Shaver). The measurements were taken in December 2004, at the end of the grazing period.

The management and feeding conditions of the animals involved in the research before the examination were the same. The beef cattle population was kept open air, without building, on an extensive peat-bog soil pasture of about 300 hectare. In the spring and summer season the feed supply was assured by the grass of the pasture, while in the autum and winter periods the supply was assured by grazing corn crop residues, corn silage and hay. Concentrate feed supplement for the cows was applied only in breeding season.

Salt block completed with macro- and microminerals (Se, Zn, Cu, Mn) was available for the animals during the whole year. Seasonal mating and inseminating was applied, the main breeding period was June and July. The calves were kept by their mothers' from their births until their weanings. Their main feed was suckled milk and creep feeding. The weaning of the calves took place in autumn. The calves were separated according to their sexes, and as replacement heifers.

During the examinations the body weight and body measurements of the above mentioned breeds were compared. The body live weight and measurements were evaluated by monofactorial variance analysis. In the cases where the results of the monofactorial variance analysis showed a significant effect, the reliability of the differences among the breeds by LSD test was examined.

The values of the various body measurements expressed in percentage of the wither height, then determined some body measure indices were calculated, too. These and their calculation methods are summarized in Table 1.

Table 1
The body measure indices and their calculation (Körpermaßindizes und deren Kalkulation)

Name of body measurement index		Calculation (HORN, 1973)
Height-index *	=	height at withers / lenght of body x 100
Rumplength-index *	=	lenght of rump / lenght of body x 100
Over increase index	=	height at rumpcasque / height at withers x 100
The index of head	=	the distance between the eyes / lenght of head x 100
Weight index by *Röhrer*	=	live weight / height at withers x 100

(*= in the original formula length of trunks was used instead of body length)

Correlation co-efficients among the live weight data, ages and the various body measurements were calculated for the whole stock as well as separately for the three most numerous breeds (Hungarian Simmental, Hereford and contracted the two - Aberdeen and Red - Angus breeds).

To predict a live weight form the body measures were used multiple regression analyses.
SPSS 9.0 statistics programme and Excel XP programmes were used for the study.

Table 2
The body measurements of cows 1 (Körpermaße der Kühe 1)

Measurement	Breed*	n	Mean	SD	CV%	Min	Max	Sig.
Average age	HS	22	5.64	2.66	47.21	2.76	11.83	P<0.01
	HE	18	7.82	1.62	20.74	3.75	9.82	
	AA	12	8.22	2.66	32.40	2.77	11.23	
	RA	13	8.50	1.74	20.42	3.70	9.72	
	LR	4	10.19	4.77	46.76	4.63	15.10	
	LI	9	5.53	1.08	19.50	2.74	6.26	
	CH	14	4.81	0.93	19.26	3.92	7.49	
	BD	11	5.67	3.07	54.23	2.74	11.59	
	SH	7	11.19	2.14	19.13	9.49	14.26	
	Total	110	7.02	2.85	40.64	2.74	15.10	
Live weight	HS	22	500 [a]	87.97	17.61	364	682	P<0.01
	HE	18	517 [a]	91.10	17.63	339	670	
	AA	12	545 [ac]	47.60	8.73	443	598	
	RA	13	551 [ac]	102.61	18.64	371	772	
	LR	4	582 [abc]	80.15	13.78	465	638	
	LI	9	591 [bc]	75.50	12.77	435	694	
	CH	14	583 [bc]	93.56	16.06	406	728	
	BD	11	638 [b]	120.62	18.91	470	818	
	SH	7	619 [c]	48.62	7.85	568	698	
	Total	110	556	96.67	17.39	339	818	
Height at withers	HS	22	134.3 [ab]	4.86	3.62	123	140	P<0.01
	HE	18	130.3 [c]	5.22	4.01	121	139	
	AA	12	131.6 [bc]	3.58	2.72	125	137	
	RA	13	132.0 [bc]	4.18	3.17	123	137	
	LR	4	134.8 [abcd]	4.79	3.55	128	139	
	LI	9	138.0 [d]	2.65	1.92	135	142	
	CH	14	137.4 [d]	4.07	2.96	130	145	
	BD	11	142.5 [e]	6.02	4.23	135	152	
	SH	7	136.6 [ad]	1.72	1.26	135	140	
	Total	110	134.8	5.67	4.21	121	152	
Height at rump	HS	22	138.3 [a]	4.92	3.56	131	145	P<0.01
	HE	18	132.0 [b]	3.65	2.76	125	139	
	AA	12	133.8 [be]	3.65	2.73	124	138	
	RA	13	137.2 [ae]	5.46	3.98	126	145	
	LR	4	136.3 [ab]	2.22	1.63	134	139	
	LI	9	143.3 [cd]	3.32	2.31	140	150	
	CH	14	141.5 [c]	3.98	2.81	135	147	
	BD	11	146.6 [d]	7.20	4.91	134	158	
	SH	7	139.3 [ac]	2.56	1.84	135	143	
	Total	110	138.3	6.24	4.51	124	158	

* HS = Hungarian Simmental; HE = Hereford; AA = Aberdeen Angus; RA = Red Angus; LR = Lincoln Red; LI = Limousin; CH = Charolais; BD = Blonde d'Aquitaine; SH = Shaver
** breeds without the same superscript differ significantly

Results

The average body measurement results received after appraising are shown in Tables 2, 3 and 4. From the data the following conclusions may be drawn:
With regard to live weight, the highest value were shown by the Blonde d'Aquitaine cows (638 kg); the individual cow weighing the most (818 kg) in the stock also comes

from this breeds. The second highest value were shown by the Shaver (619 kg), while the third in the row was the Limousin (591 kg).

Table 3
The body measurements of cows 2 (Körpermaße der Kühe 2)

Measurement	Breed	n	Mean	SD	CV%	Min	Max	Sig.
Length of body	HS	22	138.5 ^{a}	6.64	4.79	124	148	P<0.01
	HE	18	132.6 ^{b}	6.24	4.71	124	149	
	AA	12	138.2 ^{a}	6.06	4.38	125	148	
	RA	13	139.5 ^{a}	7.78	5.58	122	150	
	LR	4	141.5 ^{ac}	4.65	3.29	135	146	
	LI	9	148.3 ^{cd}	9.04	6.10	132	160	
	CH	14	142.0 ^{a}	5.83	4.11	131	151	
	BD	11	151.5 ^{d}	5.07	3.34	145	160	
	SH	7	142.1 ^{ac}	5.76	4.05	135	152	
	Total	110	140.5	8.34	5.93	122	160	
Length of rump	HS	22	43.6	3.94	9.03	37	54	NS
	HE	18	41.8	5.84	13.97	30	50	
	AA	12	42.1	3.34	7.94	37	48	
	RA	13	41.8	4.51	10.77	34	51	
	LR	4	43.3	6.50	15.03	34	49	
	LI	9	47.4	8.08	17.03	36	60	
	CH	14	43.8	4.59	10.49	36	53	
	BD	11	46.3	4.73	10.23	38	53	
	SH	7	44.7	2.56	5.73	42	50	
	Total	110	43.6	5.07	11.63	30	60	
Width of shoulders	HS	22	43.8 ^{a}	5.19	11.86	35	54	P<0.01
	HE	18	44.0 ^{a}	4.56	10.37	37	52	
	AA	12	45.3 ^{a}	4.49	9.93	38	53	
	RA	13	46.0 ^{a}	4.22	9.18	40	53	
	LR	4	48.0 ^{ab}	5.29	11.02	41	53	
	LI	9	51.4 ^{b}	2.60	5.06	48	54	
	CH	14	45.9 ^{a}	5.20	11.34	34	55	
	BD	11	50.3 ^{b}	6.37	12.68	41	64	
	SH	7	52.9 ^{b}	3.67	6.95	47	58	
	Total	110	46.5	5.51	11.84	34	64	
Width of haunch (1^{st} width of rump)	HS	22	51.8 ^{a}	4.33	8.35	45	58	P<0.01
	HE	18	56.0 ^{bc}	3.65	6.51	47	61	
	AA	12	53.9 ^{acef}	2.31	4.29	50	58	
	RA	13	56.0 ^{bdf}	3.58	6.40	52	64	
	LR	4	57.0 ^{bc}	3.16	5.55	53	60	
	LI	9	58.3 ^{b}	2.29	3.93	54	62	
	CH	14	54.1 ^{acd}	2.53	4.67	49	57	
	BD	11	55.5 ^{bde}	6.19	11.14	43	63	
	SH	7	57.7 ^{b}	3.25	5.63	51	61	
	Total	110	55.0	4.16	7.56	43	64	

With respect to wither height, the highest value were shown by the Blonde d'Aquitaine (142.5 cm), significantly (P<0.05) surpassing the heights of the other breeds. The Limousin (138.0 cm), the Charolais (137.4 cm), the Shaver (136.6 cm) and the Lincoln Red (134.8 cm) did not statistically differ from one another, but they were significantly (P<0.05) higher than the two Angus breeds (131.6 cm and 132.0 cm, respectively) and the Hereford (130.3 cm).

Table 4
The body measurements of cows 3 (Körpermaße der Kühe 3)

Measurement	Breed	n	Mean	SD	CV%	Min	Max	Sig.
Width of sitterbulbs (3^{rd} width of rump)	HS	22	19.3 ^{a}	2.47	12.83	14	24	P<0.01
	HE	18	18.6 ^{a}	1.46	7.89	16	20	
	AA	12	19.8 ^{ac}	1.48	7.52	16	22	
	RA	13	19.4 ^{a}	3.33	17.18	12	26	
	LR	4	20.5 ^{ab}	2.08	10.15	18	23	
	LI	9	23.0 ^{b}	1.73	7.53	19	25	
	CH	14	21.6 ^{bc}	1.83	8.47	18	24	
	BD	11	23.2 ^{b}	2.32	9.99	21	28	
	SH	7	21.7 ^{bc}	4.03	18.56	17	28	
	Total	110	20.4	2.77	13.59	12	28	
Length of head	HS	22	50.7 ^{abg}	2.53	5.00	47	57	P<0.01
	HE	18	47.9 ^{c}	1.84	3.85	44	51	
	AA	12	48.7 ^{cdf}	1.67	3.43	46	52	
	RA	13	50.0 ^{deg}	2.83	5.66	45	55	
	LR	4	52.8 ^{abe}	2.22	4.20	51	56	
	LI	9	50.4 ^{abd}	3.28	6.51	46	55	
	CH	14	50.4 ^{abef}	1.50	2.98	47	52	
	BD	11	52.0 ^{a}	3.13	6.02	48	56	
	SH	7	52.1 ^{abe}	2.91	5.58	49	57	
	Total	110	50.2	2.74	5.46	44	57	
Width of head	HS	22	20.5 ^{abc}	1.18	5.79	19	23	P<0.01
	HE	18	20.8 ^{ad}	1.26	6.08	18	22	
	AA	12	19.7 ^{bcg}	1.07	5.46	18	22	
	RA	13	19.9 ^{cd}	1.26	6.30	18	23	
	LR	4	20.8 ^{ac}	0.96	4.61	20	22	
	LI	9	18.7 ^{be}	1.12	5.99	17	21	
	CH	14	19.7 ^{bcf}	1.14	5.78	18	22	
	BD	11	18.7 ^{efg}	1.62	8.64	16	21	
	SH	7	21.0 ^{ad}	1.53	7.27	19	23	
	Total	110	20.0	1.42	7.09	16	23	

Considering height at rump, again the Blonde d'Aquitaine was the heighest 146.6 cm); however, it did not differ from the Limousin (143.3 cm), though it significantly surpassed the other breeds. The two Anguses (133.8 and 137.2 cm, respectively) did not differ from each other but their heights were significantly lower than the Charolais (141.5 cm) or the Shaver (139.3 cm), which showed the third heighest measures. The lowest height at rump belonged to the Hereford (132.0 cm).

With respect to body length, the longest breed was the Blonde d'Aquitaine again (151.5 cm), whereas the second longest was the Limousin (148.3 cm), which statistically did not differ from it. The Shaver (142.1 cm), the Charolais (142.0 cm), the Lincoln Red (141.5 cm), the Aberdeen Angus (139.5 cm), the Hungarian Simmental (138.5 cm) and the Red Angus (138.2 cm) did not differ from one another, but were significantly ($P<0.05$) longer than the shortest Hereford (132.6 cm).

The highest values in length of the rump was shown by the Limousin breed (47.4 cm), but it differed no significantly to the other breeds.

Considering width of shoulder, the widest breed was the Shaver (52.9 cm), which did not differ significantly from the Limousin (51.4 cm) and the Blonde d'Aquitaine (50.3 cm) but showed a significantly ($P<0.05$) higher value than the Charolais, the two Angus breeds, the Hereford and the Hungarian Simmental. The latter five breeds did not differ from this respect.

The highest value in width of the haunch (1st width of the rump) was shown by the Limousin (58.3 cm), but it did not differ significantly (P<0.05) from the handquarters width I of the Shaver (57.7 cm), the Lincoln Red (57.0 cm), the Hereford (56.0 cm), the Red Angus (56.0 cm) and the Blonde d'Aquitaine (55.5 cm).
Examining 3rd width of rump, it may be concluded that the highest value were shown by the Blonde d'Aquitaine cows (23.2 cm), while the lowest values were given by the Hereford cows (18.6 cm).
With respect to length of head, the breeds showed smaller but significant diffferences. The longest head measurement was shown by the Lincoln Red breed (52.8 cm).
With regard to width of head, the breeds showed small differences. From the examined breeds, the Shaver (21.0 cm) can be characterized by the widest head, while the narrowest headed breeds are the Limousin and the Blonde d'Aquitaine. In the case of the Limousin and the Blonde d'Aquitaine breeds, the wider rump and the narrower yet longer head found in our examinations supports the easier calving that characterizes the breeds. The greatest head width (20.5 cm) and the smaller values for the width of the rump may be one of the reasons responsible for the calving difficultes.
The relative body measurements and body indices calculated for the breeds that are shown in Table 5. As the data shown the results are fairly similar that means no differences between the breeds evaluated.

Table 5
The body measure indices (Körpermaßindizes)

Breed	Height-Index *	Rumplengh-index *	Over increase index	Index of head	Weight index by *Röhrer*
Hungarian Simmental	96.97	31.48	102.98	40.36	398.36
Hereford	98.27	31.52	101.30	43.39	379.13
Aberdeen Angus	95.22	30.46	101.67	40.41	415.65
Red Angus	94.62	29.96	103.94	39.85	414.39
Lincoln Red	95.27	30.60	101.11	39.34	424.33
Limousin	93.05	31.96	103.84	37.00	410.14
Charolais	96.76	30.85	102.98	39.09	452.69
Blonde d'Aquitaine	94.06	30.56	102.88	36.01	454.04
Shaver	96.13	31.46	101.98	40.27	431.92
Total	95.94	31.03	102.60	39.84	422.12

(with the * signed indices in the original formula in lieu of lenght of body the length of the trunk is)

Table 6 shows the correlation (r) values of body weight, age and body measurements for the whole stock as well as separately for the three most numerous breeds the Hungarian Simmental the Hereford and the Angus (Aberdeen and Red Angus together).
In all cases the live weight has an average or close (r = 0.40 - 0.83; P<0.01 in most cases) and positive correlation with the various body measurements, but the correlation between the age and the body measurements is loose (r = 0.01 - 0.46; NS) but positive. The correlation among the various body measurements is medium or close (r = 0.22 - 0.81; P<0.05 in most cases) and positive.

Table 6
The correlation of live weight and age with the body measurements (Beziehungen zwischen Lebendgewicht, Alter und Körpermaßen (r))

	Live weight	Age	Height at withers	Height at rump	Length of body	Length of rump
Hungarian Simmental						
age	0.44*	-				
height at withers	0.55**	0.08	-			
height at rump	0.50*	0.01	0.77***	-		
length of body	0.67**	0.37	0.47*	0.58**	-	
length of rump	0.46*	0.12	0.63**	0.44*	0.50*	-
width of haunch	0.78***	0.27	0.48*	0.44*	0.76***	0.69***
Hereford						
age	0.21	-				
height at withers	0.58*	0.32	-			
height at rump	0.76***	0.02	0.67**	-		
length of body	0.53*	0.03	0.32	0.27	-	
length of rump	0.66**	0.29	0.49*	0.48*	0.49*	-
width of haunch	0.83***	0.31	0.50*	0.49*	0.44	0.51*
Angus						
age	0.23	-				
height at withers	0.59**	-0.06	-			
height at rump	0.55**	-0.04	0.78***	-		
length of body	0.57**	0.20	0.51**	0.48*	-	
length of rump	0.40*	0.46*	0.41*	0.22	0.60**	-
width of haunch	0.63**	0.31	0.72***	0.58**	0.42*	0.48*
Total						
age	0.23*	-				
height at withers	0.64***	-0.10	-			
height at rump	0.61***	-0.20*	0.81***	-		
length of body	0.57***	-0.03	0.58***	0.64***	-	
length of rump	0.48***	0.11	0.46***	0.41***	0.58***	-
width of haunch	0.70***	0.36***	0.40***	0.34***	0.42***	0.43***

(* = P<0.05, ** = P<0.01, *** = P<0.001)

The results of the multiple regression analysis are shown in Table 7. In the examined body measurements only three, the height at rump, width of shoulders and width of haunch has significant effect on the live weight (ŷ).

Table 7
The results of regression analysis (Ergebnisse der Regressionsanalyse)

Model	B	SE	Sig.	R^2
Constant	-884.837	130.319	P<0.01	0.68
Height at rump (HR) (cm)	5.014	0.994	P<0.01	
Width of shoulders (WS) (cm)	5.017	1.377	P<0.01	
Width of haunch (WH) (cm)	9.346	1.667	P<0.01	

The linear regression equation as follows:

$$\hat{y} = (5.014 \times HR) + (5.017 \times WS) + (9.346 \times WH) - 884.837$$

Discussion

Similarly to the data found in literature, different cattle breeds kept under similar conditions show differences in all body measurements. Namely, the breed with the heaviest weight, the highest withers and rumps as well as with the longest body was the Blonde d'Aquitaine. In this respect the Limousin and the Charolais came second alternately, which could be expected, as from the examined breeds, these three beeds can be ranked among the large sized cattle that are paternal ones in cross-breedings. From the smaller, maternal breeds the Shaver showed the largest body measurements. In accordance with literature references, from the British breeds the Lincoln Red could be characterized by the largest body measurements, surpassing the Angus and the Hereford.

The examination of the relationship between the live weight and the various body measurements showed similar results to presented by various authors (WOLLERT et al., 1987; SCHRAMM et al., 1989; ENGELHARDT et al., 1992; WILSON, 1996; TŐZSÉR et al., 1995, 2001; etc.). Namely, average or close and positive correlation between the live weight and most of the body measurements was found. This facts repeatedly calls the attention to the importance of taking cattle body measurement, and offers opportunity for estimating parameters in relation to the various body measurements.

The current study had confirmed considerable differences between beef cattle races. Measurements such as width of haunch or height of rump or wither and other traits were used to study skeletal development. Therefore it can conclude that body measurements have been of recurring interest interest in beef cattle selection and breeding programs.

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References

ARANGO, J. A.; CUNDIFF, L. V.; VAN VLECK, L. D.:
Genetic parameters for weight, weight adjusted for body condition score, height, and body condition score in beef cows. J. Anim. Sci. **80** (2002a), 3112-3122

ARANGO, J. A.; CUNDIFF, L. V.; VAN VLECK, L. D.:
Breed comparsions of Angus, Charolais, Hereford, Jersey, Limousin, Simmental and South Devon for weight, weight adjusted for body condition score, height, and body condition score in beef cows. J. Anim. Sci. **80** (2002b), 3123-3132

ARANGO, J. A.; CUNDIFF, L. V.; VAN VLECK, L. D.:
Comparsions of Angus-, Braunvieh-, Chianina-, Hereford-, Gelbvieh-, Maine Anjou-, and Red Poll-sired cows for weight, weight adjusted for body condition score, height, and body condition score in beef cows. J. Anim. Sci. **80** (2002c), 3133-3141

ARANGO, J. A.; CUNDIFF, L. V.; VAN VLECK, L. D.:
Breed comparsions of Angus, Brahman, Hereford, Pinzgauer, Sahiwal, and Tarentaise for weight, weight adjusted for body condition score, height, and body condition score in beef cows. J. Anim. Sci. **80** (2002d), 3142-3149

ARANGO, J. A.; CUNDIFF, L. V.; VAN VLECK, L. D.:
Comparsions of Angus, Charolais, Galloway, Hereford, Longhorn, Nellore, Piedmontese, Salers, and Shorthorn breeds for weight, weight adjusted for body condition score, height, and body condition score in beef cows. J. Anim. Sci. **82** (2004), 74-84

BALIKA, S.; BODÓ, I.:
Important beef breeds. Taurina Cattle Breeder Corporation, Budaörs (Jelentősebb húsmarha-fajták. Taurina Szarvasmarha-tenyésztő Közös Vállalat, Budaörs) (1984)

BALIKA, S.:
The type-framing of beef cattle. Liv. and Meat Prod. (A húshasznú szarvasmarha típusformálása. Vágóállat és Hústermelés) **20** (1990), 31-34

BAUER, K.; STEINWENDER, R.; STODULKA, R.:
Mutterkuh-Haltung. Leopold Stocker Verlag, Graz, Austria (1997)

BODÓ, I.; ESZES, F.; GERS, I.; JÁVORKA L.:
Digitalised video-pictures use in animal breeding. Veternary University, Budapest, Academy Report Meeting, Genetics Section. (Digitalizált videoképek alkalmazása az állattenyésztésben. Állatorvostudományi Egyetem, Budapest, Akadémiai Beszámoló Ülés, Genetika szekció) (1997)

BREM, G. /editor/:
Exterieurbeurteilung landwirtschaftlicher Nutztiere. Agricultural Publisher, Budapest (1998)

ENGELHARDT, G.; BRANSCHIED, W.; GLODEK, P.:
Schätzung der grobgeweblichen Schlachtkörperzusammensetzung beim Rind mit Hilfe von Hilfsmerkmalen. Arch. Tierz., Dummerstorf **35** (1992), 561-569

FELIUS, M.:
Cattle Breeds an Encyclopedia. Misset uitgeverij, postbus 4, 7000 BA Doetinchem - Netherland (1995)

GERE, T.; BARTOSIEWICZ, L.:
Relation between the purpose of utilization and postembrional development of body measures in cattle. Hung. J. Anim. Prod. (A szarvasmarha hasznosítási típusának összefüggése egyes testméretek posztembrionális növekedésével. Állattenyésztés.) **28** (1979), 245-255

HARTJEN, P.; PREISINGER, R.; ERNST, E.:
Schätzung der Schlachtkörperzusammensetzung beim Rind. I. Mitt.: Schätzung der Schlachtkörperzusammensetzung am lebenden Rind mit Hilfe von Ultraschallmessungen und Lebendmassen. Arch. Tierz., Dummerstorf **36** (1993), 315-324

HOLLÓ, I.; HORVÁTH, Á.:
Study on the interrelationship between pelvic measures and parturition of cows. Hung. J. Anim. Prod. (Előzetes beszámoló a tehenek medenceméretei és az ellés lefolyása közötti összefüggés vizsgálatáról. Állattenyésztés) **28** (1979),21-25

HORN, A. /editor/:
Cattle breeding. Agricultural Publisher, Budapest. (Szarvasmarhatenyésztés. Mezőgazdasági Kiadó, Budapest) (1973)

HORN, P. /editor/:
Animal Breeding 1. Agricultural Publisher, Budapest (Állattenyésztés I. Mezőgazda Kiadó, Budapest) (1995)

KÜHN, CH.; BELLMANN, O.; VOIGT, J.; WEGNER, J.; GUIARD, V.; ENDER, K.:
An experiment apporach for study the genetic and physological background of nutrient transformation in cattle with the respect to nutrient secretion and accretion type. Arch. Tierz., Dummerstorf **45** (2002), 317-330

KMET, J.; SAKOWSKI, ZT.; HUBA, J.; PESKOVICOVA, D.; CHRENEK, J.; POLAK, P.:
Application of video Image analysis in the slaughter value estimation of live Simmental bulls. Arch. Tierz., Dummerstorf **43** (2000), 411-416

MÉSZÁROS, GY.:
Novel method for taking body measures of cattle and analysis of body propotions. Hung. J. Anim. Prod. (Új módszer a szarvasmarhák testméreteinek felvételére és testarányaik elemzésére. Állattenyésztés és Takarmányozás) **26** (1977), 525-532

NEUMANN, W.; WEIHER, O.; MARTIN, J.:
Ergebnisse von Untersuchungen zur Züchtung von Fleischrindlinien durch Kombinationskreuzung. Arch. Tierz., Dummerstorf **31** (1988), 251-257

PAPSTEIN, H. J.; ENDER, K.; SPANKE, K.; PAPSTEIN, I.; GABEL, M.:
Wachstumsuntersuchungen an schwarzbunten Bullen verschiedener Körperbautypen. Arch. Tierz., Dummerstorf **36** (1993), 597-606

POLGÁR, J. P.; SZŰCS, E.; SZABÓ, F.:
Auswirkungen einer milchbetonten Selektion auf die Wachstumsintensität und den Körperbau von Jungbullen der Rassen Holstein Friesian und Ungarisches Fleckvieh. Arch. Tierz., Dummerstorf **40** (1997), 505-510

SAMBRAUS, H. H.:
Farbatlas Nutztierrassen. ULMER Verlag GmbH, Stuttgart, Deutschland (2001)
SCHRAMM, R. D.; OSBORNE, P. I.; THAYN, W. V.; WAGNER, W. R.; INSKEEP, E. K.:
Phenotypic relationships of scrotal circumference to frame size and body weight in performance-tested bulls. Theriogenology **31** (1989), 495-503
SZABÓ, F.:
Data to reciprocal crossing of Hungarian Simmental and Hereford. Hung. J. Anim. Prod. (Adatok magyar tarka és hereford szarvasmarhafajták reciprok keresztezéséről. Állattenyésztés és Takarmányozás) **39** (1990), 129-138
SZABÓ, F. /editor/:
Beef cattle breeding. Agricultural Publisher, Budapest. (Húsmarhatenyésztés. Mezőgazda Kiadó, Budapest) (1998)
TŐZSÉR, J.; NAGY, A.; GERSZI, K.; MÉZES, M.; DOMOKOS, Z.; KERTÉSZ, I.; FEKETE, T.:
Changes in phenotypic relationship of scrotal circumference with chest width, chest depth and liveweight in Charolais young bulls as a function of age. Hung. J. Anim. Prod. (A herekörméret, a mellkasszélesség és mélység, valamint az élősúly fenotípusos összefüggésének változása az életkor függvényében, charolais fajtájú tenyészbika jelölteknél. Állattenyésztés és Takarmányozás) **44** (1995), 203-210
TŐZSÉR, J.; DOMOKOS, Z.; ALFÖLDI, L.:
A proposition to correct some body measurements in Charolais cows. Hung. J. Anim. Prod. (Javaslat charolais fajtájú tehenek néhány testméretének korrigálására. Állattenyésztés és Takarmányozás) **49** (2000a), 13-22
TŐZSÉR, J.; DOMOKOS, Z.; RUSZNÁK, J.; SZELÉNYI, L.; GÁBRIELNÉ TŐZSÉR, GY.:
Data on body measurements of Charolais cows. Hung. J. Anim. Prod. (Charolais fajtájú tehenek testméretének alakulása. Állattenyésztés és Takarmányozás) **49** (2000b), 207-216
TŐZSÉR, J.; SUTTA, J.; BEDŐ, S.:
The evaluation of video pictures for measurements of cattle. Hung. J. Anim. Prod. (Videókép-analízis alkalmazása a szarvasmarhák testméretének értékelésében. Állattenyésztés és Takarmányozás) **49** (2000c), 385-392
TŐZSÉR, J.; DOMOKOS, Z.; ALFÖLDI, L.; HOLLÓ, G.; RUSZNÁK, J.:
Body measurements of cows in a Charolais herd with different genotype. Hung. J. Anim. Prod. (Különböző génarányú charolais tehenészet teheneinek testméretei. Állattenyésztés és Takarmányozás) **50** (2001), 15-22
VAN MARLE-KÖSTER, E.; MOSTERT, B. E.; VAN DER WESTHUIZEN, J.:
Body measurement as selection criteria for growth in South African Hereford cattle. Arch. Tierz., Dummerstorf **43** (2000), 5-15
WILSON, D. E.:
Angus mature cow size genetic evaluation. Angus Journal, March, 8. (1996)
WOLLERT, J.; TILSCH, K.; GÖRLICH, L.; WARZECHA, H.:
Phänotypische und genetische Parameter produktiver Leistungsmerkmale von Fleischrindkühen. Arch. Tierz., Dummerstorf **30** (1987), 413-420
WOLLERT, J.; TILSCH, K.; GÖRLICH, L.; WARZECHA, H.; BREITENSTEIN, K. G.:
Untersuchungen zur Genauigkeit der Zuchtwertschätzung von Wachstumsmerkmalen bei Fleischrindkühen. Arch. Tierz., Dummerstorf **32** (1989), 139-146

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Authors' address
SZABOLCS BENE (PhD student); BARNABÁS NAGY (PhD student); LAJOS NAGY (PhD student, head of beef cattle farm); BALÁZS KISS (agrarian-engineer student)
Dr. PÉTER J. POLGÁR (associate professor, CSc); Prof. Dr. FERENC SZABÓ (professor, DSc)
University of Pannonia, Georgikon Faculty of Agriculture, Deák Ferenc str. 16., 8360 KESZTHELY, HUNGARY

E-Mail: bszbb@citromail.hu; szf@georgikon.hu