Bulgarian Journal of Agricultural Science, 25 (No 6) 2019, 1254–1260

Study on the exterior of cow Limousin cattle breed, bred in Bulgaria

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Abstract

Karamfilov, S., Nikolov, V., & Malinova, R. (2019). Study on the exterior of cow Limousin cattle breed, bred in Bulgaria. *Bulgarian Journal of Agricultural Science, 25*(6), 1254–1260

Exterior measurements were taken from 116 female animals of the Limousin breed, aged one (n-15), two (n-17), and 3-7 (n-84) years, imported from Austria, France, and such born in Bulgaria. It is established that these beef cattle are relatively large: the height at the withers is 135.7 ± 1.52 cm on average, the oblique body length is 166.0 ± 1.78 cm, the chest girth is 199.1 ± 2.03 cm, and the cannon bone girth is 19.96 ± 0.18 cm. These animals are deep, wide, with well-muscled chest and rump, and relatively thin bones. The origin has significant effect on the exterior parameters of the cattle, as the cattle imported from Austria are the largest. The cattle imported from France and those born in Bulgaria are not significantly different in their external dimensions. The Limousin calves develop well in Bulgaria, as at the age of one year they reach 93-95% of the height of the body at a fully mature age, 90% of the oblique body length and the chest girth, 95% of the girth of the cannon bone. At the age of two years, the stated parameters are respectively 97-99% of the height, 93% of the oblique body length, 95% of the chest girth and 96% of the girth of the cannon bone.

Keywords: Limousin; beef cattle; exterior; development

Introduction

The French breed of beef cattle Limousin is one of the oldest continental breeds of cattle. By the XVII century, these "forest" animals were used mainly for work due to their large size and strength, despite the fact that even back then, the oxen, aged 8-10 years were fattened and sent walking to big cities like Bordeaux and Paris. (Limousine Mag, 2012). In the following centuries the breed has been an important part of the history of the eponymous province as at the beginning of the XIX century (1808), the cattle were considered the most important and lucrative branch of agriculture (Grandcoing, 2003).

In 1886 the herd-book of the Limousin breed was created. The requirements entered in it were very high and for two years, only 479 animals were registered (Limousine Mag, 2012).The period of creation of the herd book coincided with the rise of interest in English beef cattle breeds and crossing, but the analyses of the documents and the literature sources (Frioux, 2002; Grandcoing, 2003) confirm that the position of one the supporters of the breed – Edmond Teisserenc de Bort, who stated the categorical opinion of the members of the French Association for Scientific Development (1890) that the breeders of Limousin have created their breed without foreign blood, through selection and feeding improvement (Grandcoing, 2003).

After a period of decline at the beginning of the XX century, the breed gained huge popularity for a very short period of time and was revived in the 1960's, thanks to its valuable biological and economic qualities. The cows have high fertility (93.4%), the first calving is at the age of 34.9 months, the average duration of the period between calving is 382 days, the average age of the cows in the reproductive herds is 5.9 years (RBC, 2018). The calves are born with live weight of 40-43 kg (Limousine Mag, 2012) and due to the high milky of the mothers they grow fast (RBC, 2018). In

weaning, at the age of 210 days, the males reach live weight of 285 kg, and the females – 259 kg. Limousin has high meat yielding productivity – the average daily gain until the weaning is 1.035-1.145 kg, and over than 1.300 kg in the finishing period (RBC, 2018). The dressing percentage of the young animals is 62-65%; the muscles/bones ratio – 4.7/1, muscles/fat – 7/1; 78% of the carcasses are classified in categories E or U (Limousine Mag, 2012). The meat from Limousin in France has geographical distinctness, with three official labels for quality: "Bœuf Limousin", "Limousin free-range veal" and "Limousin Junior" (FGE, 2017).

The region where the breed originated is characterized with rugged terrains, rocky soil and harsh climate. This has contributed to the creation of animals with high adaptability, which can be bred outdoors all year round (AFS, 2017). Currently, the Limousin is the second most populous breed in France, with more than 1.1 million cows (FGE, 2019) and is being bred in more than 80 countries (La Limousine, 2019). Particular attention should be paid to the fact that the Limousin has been the most common beef cattle breed in Great Britain for more than 20 years (Glasgow, 2019), as it takes 25% of the total head of livestock to be slaughtered, followed by the Aberdeen with 19% (Limousin, 2018).

The assessment of the exterior has always had huge significance for the Limousin, as well as for the other beef cattle breeds. As far back as the end of XVIII century, there were special requirements for the cattle to be fattened (La Manièred' engraisser les bœufs,1787), (Delhoume, 2004) – "the traders and farmer in Limousin want the bulls to have big head, short, rounded muzzle, wide chest, big legs and hoofs, rounded belly, wide and rounded ribs, big round thighs". At the end of the XIX century, the following were among the main accents in the selection by exterior: average body size, dark golden-red colour, deep chest, muscular back line, well placed tail and highly muscular thighs (AFS, 2017).

The animals from the Limousin breed are imported in Bulgaria from different countries, where the breed standards often vary. The aim of the present study is to establish main exterior parameters of Limousin cows, bred in the country.

Material and Methods

The study was performed in 2017. Exterior measurements were taken from 116 Limousin cows and heifers, bred in three farms in Lovech (n-66), Stara Zagora (n-14), and Blagoevgrad (n-36) regions. The animals are aged 1 (n-15), 2 (n-17), and 3-7 (n-84) years, and are of 3 origins – imported from Austria and France, as well as such born in Bulgaria.

The conditions of the three farms are similar. During the whole year, the rations include concentrated fodder, and the pastures are limited within the region of the farm. The farms are under the selection control of the "National association of beef cattle in Bulgaria"– Sofia.

During the period of measurement, the animals are fixed in a cattle crushe, under the requirements and conditions for taking exterior measures. The measures are taken with the routine zoo technical instruments –Lydtin's rod, Wilkens' compass, and a centimetre tape.

Multivariate dispersion analysis was used for processing the data, as the linear models for cows (aged 3-7 years) have the following common statistical type:

$$Yijkl = \mathrm{m} + AGi + OLj + Ik + eijk \quad (1)$$

where: *Yijkl* – monitoring vector; *m* – overall average constant; *AGi*, *OLj*, *Ik* are fixed effects, respective to the age group (i = 5), the origin (j = 3), and the individual, *eijkl* – residual variance.

The data for the one-year-old and two-year-old animals is processed separately, using the abovementioned model, excluding the 'age' factor.

The statistical processing is conducted via specialized software IBM SPSS 21.

Results and Discussion

Limousin beef cattle bred in Bulgaria are relatively large. The average height at the cows' withers is 135.7 ± 1.52 cm, the oblique body length – 166.0 ± 1.78, the chest girth – 199.1 ± 2.03 (Table 1). The size of beef cattle is of great importance – the ratio of the size and the weight specifies the possibility of growth, the rapidness of maturation, the quantity of fats in the body, etc. (Barham et al., 2019).

The animals we measured are taller than the ones measured by Gorinov and Lidji (2016), who established an average height at the withers of 129.27 cm of first-calving cows of the same breed, bred within the period of 2008-2015.

The breeding organization of Limousin in France recommends that the height of the withers of the cows should be 135-145 cm, and that of the live weight of the fully-grown cows – between 650-850 kg (FGE, 2018). In Switzerland, standard for the breed states that the height at the withers is 130-141 cm, reached in combination with the age of the first calving at the age of 27-30 months (MCH, 2019). In Hungary, Bene et al. (2007) study the linear measurements of the different beef breeds and establish that the Limousin beef cattle are 138±2.65 cm tall on average, the height at the rumpis 143.3±3.23 cm, the oblique body length is 148.3±9.04 cm, and the rump length is 47.4±8.08 cm. In their study of first-calving cows of the Limousin breed in Poland, Czerniawska-Piątkowska et al. (2012) established values that are similar

Table 1. Exterior measurements of the Limousin beef cattle, aged between 3 and 7 years (N-84)

Trait	LS ± SE	SD	min	max
Height at the withers, cm	135.7 ± 1.52	7.48	123	155
Height at back, cm	135.8 ± 0.77	4.58	124	146
Height at loin, cm	138.8 ± 0.78	4.57	125	150
Height at the hook bone, cm	140.5 ± 0.77	4.41	128	152
Height at tail setting, cm	139.9 ± 0.81	4.53	128	149
Height at rump, cm	126.0 ± 0.98	5.42	110	138
Oblique body length, cm	166.0 ± 1.78	9.04	137	190
Straight body length, cm	127.1 ± 1.27	6.32	109	145
Chest length, cm	85.1 ± 1.38	6.66	61	100
Chest width, cm	47.5 ± 0.78	4.10	35	60
Chest depth, cm	68.8 ± 0.66	3.31	60	78
Chest girth, cm	199.1 ± 2.03	10.50	170	232
Length of rump, cm	55.8 ± 0.60	3.48	44	67
Width of rump behind hips, cm	53.2 ± 0.53	2.70	45	62
Width of rump at hip joints, cm	49.2 ± 0.45	2.38	43	58
Width at the pin bones, cm	14.4 ± 0.34	1.72	10	20
Cannon bone girth, cm	19.96 ± 0.18	1.01	17	22

to ours – height at the withers of 135.62 cm and chest girth of 194.07 cm.

The back line of the measured animals is relatively straight, with a slightly convex at rump that starts at the loin region. The height at the withers is 2.2% shorter than the height of the loin, and 3% shorter than the height at the tail base and the hook bone. The size gain is typical for the animals inhabiting rough terrain (Nikolov, 2012; Nikolov & Karamfilov, 2014), as is the case with the Limousin. With the body heights, the variability of the height at the withers is the highest, and the lowest variability is at the tail base.

According to the English standard (LUK, 2018), the animals of the Limousin breed must be long-shaped, the anterior part of the body must be well-built, the chest must be deep and wide, with well-structured and rounded ribs, the back must be wide, straight and well-muscled. The cows we measured are long enough, "rectangular-shaped", as the oblique body length exceeds the height at the withers with 22.4% on average.

The chest is large, deep, and wide. Its length is 23.6% greater than the depth, which, in its turn, is 50.7% of the height at the withers. The chest girth is 20% larger than the oblique body length. In comparison to the cows of the Aberdeen-Angus breed which we have measured, it is 17.8% larger (Karamfilov & Nikolov, 2018). The chest length, being a part of the length of the body, forms 66.9% of the straight and 51.2% of the oblique body length.

The rectangular shape is typical for the animals with 'a view from above' as well. The width of the chest is 3.3% smaller than the width of the rump measured at the hips, and 10.7% smaller than the width of the rump at the hook bones. These proportions also tell of a well-built rump.

The rump has been paid special attention in almost all the breeding programmes including linear assessment of the exterior in beef cattle breeding (ICAR, 2015). It has to be long enough, wide, and with a normal slope, in order to provide easy calving. The Limousin breed is famous for its ease calving, reaching up to 99% (NAF, 2018), that is why the rump is of special importance. The cows we measured have a long and wide rump. The length is almost equal to the width at the hook bones. It is 8.3% greater than the width of the hip joints, which is evidence of a wide pelvic cavity.

The hip joints lay on a wide basis, as the body width at them is almost equal to the chest width. The long and wide rump is a prerequisite for a stable wide grip of the hip joints, and the development of the wide and deep thighs.

On the background of the good prerequisites for the development of the muscles, the Limousin cattle are with thin and fine bones, which contribute for the achievement of a dressing percentage of over 60% (CIS, 2018). The girth of the cannon bone, which is the criterion of the development of the bones of the living animals, is 19.96 ± 0.18 cm of the animals we measured – with low phenotype individual variation – 1.01%. This girth is almost equal to the girth of the cannon bone of the Aberdeen-Angus cattle – 19.73± 0.18 cm, which is considered to be the one with the breeds with thinnest bones among the beef cattle. The girth of the cannon bone of the Limousin is 8.5% smaller than the cows of the Montbeliarde breed (Karamfilov, 2014).

The cows of different origin are significant different with their body height and length, the shape of the rump, and the development of the bones (Table 2). Significant differences of the exterior of the Limousin cattle of different origin (the Netherlands, Austria, and Germany), bred in our country, are also established by Gorinov and Lidji (2016).

Table 2. Influence of the age group and the origin on the exterior measurement of the Limousin cattle (F-criteria and confidence level).

Trait	Age group	Origin
Height at the withers	0.527	1.583
Height at back	2.063*	6.821**
Height at loin	1.639	6.176**
Height at the hook bone	0.931	5.205**
Height at tail setting	0.935	3.733*
Height at rump	0.856	6.733**
Oblique body length	1.104	2.808*
Straight body length	1.940	0.318
Chest length	1.060	1.957
Chest width	1.606	0.805
Chest depth	1.857	1.622
Chest girth	1.640	1.939
Length of rump	4.094**	5.981**
Width of rump behind hips	2.279*	0.819
Width of rump at hip joints	1.946	3.512*
Width at the pin bones	0.447	1.864
Cannon bone girth	0.989	2.510*

***P < 0.001; **P < 0.01; *P < 0.05

The largest cows in our study are the ones imported from Austria, as all the exterior measurements exceed the ones born in our country and the ones imported from France (Table 3). The latter are larger than the ones born in our country, but the differences are insignificant – from 1 to 3 cm, regarding the heights; 4 cm of the oblique body length; from 1 to 5 cm of the parameters of the chest; 3 cm of the measurement of the rump. The animals born in Bulgaria have thinner bones.

The cows imported from Austria are 6-10 cm taller, than the ones born in our country. The biggest difference is in the height at the rump, as with Austrian cows the rump is with smaller slope than the ones of the Bulgarian and French ones. The cows imported from Austria are also longer, but with relatively less developed chest. The chest is shorter than the cows born in France, and the width and depth are less than 0.5 cm bigger. The rump has wider entrance but is relatively narrower at the hip joints. The Austrian cows have more massive bones.

The maturity at which the heifers can be inseminated requires reaching of certain level of development, as most frequently criterion of this is live weight. The breeding organization of Limousin in France (LIU, 2018), recommends the females at age 12-15 months to be with body weight of 315-410 kg, at the age of 18-24 months – 425-500 kg, and at age 26-36 months – more than 600 kg.

Table 3. Exterior measurements of mature Limousin cattle born in Bulgaria, imported from Austria and France

Trait	Bulgaria		Austria		France	
	N – 25		N – 16		N – 43	
	LS ± SE	SD	LS ± SE	SD	LS ± SE	SD
Height at the withers, cm	133.0 ± 2.29	4.01	140.4 ± 2.88	2.83	135.3 ± 2.65	8.55
Height at back, cm	133.6 ± 1.16	4.14	140.4 ± 1.45	3.09	134.6 ± 1.34	3.77
Height at loin, cm	136.2 ± 1.17	4.44	143.4 ± 1.47	3.05	138.2 ± 1.35	3.88
Height at the hook bone, cm	137.8 ± 1.16	4.24	144.9 ± 1.45	2.64	140.5 ± 1.33	3.76
Height at tail setting, cm	137.2 ± 1.22	4.51	144.0 ± 1.54	2.57	140.4 ± 1.41	4.03
Height at rump, cm	122.5 ± 1.48	4.71	132.3 ± 1.86	3.40	125.2 ± 1.71	4.90
Oblique body length, cm	162.1 ± 2.68	10.83	172.5 ± 3.36	7.01	166.0 ± 3.10	7.88
Straight body length, cm	126.6 ± 1.91	6.89	128.4 ± 2.40	6.48	126.4 ± 2.21	6.10
Chest length, cm	83.4 ± 2.08	6.42	85.6 ± 2.61	11.26	88.4 ± 2.40	4.70
Chest width, cm	46.3 ± 1.18	4.50	48.9 ± 1.48	3.25	48.5 ± 1.36	3.77
Chest depth, cm	67.8 ± 1.00	3.70	70.0 ± 1.25	3.25	69.6 ± 1.15	3.06
Chest girth, cm	196.2 ± 3.05	13.90	205.1 ± 3.82	11.87	197.2 ± 3.52	7.24
Length of rump, cm	53.9 ± 0.90	3.93	58.8 ± 1.13	3.81	56.3 ± 1.04	2.50
Width of rump behind hips, cm	52.8 ± 0.81	2.82	54.3 ± 1.01	2.10	52.7 ± 0.93	2.69
Width of rump at hip joints, cm	48.0 ± 0.68	2.54	50.5 ± 0.85	2.80	50.1 ± 0.78	1.94
Width at the pin bones, cm	13.6 ± 0.52	1.59	15.6 ± 0.65	1.08	14.8 ± 0.60	1.70
Cannon bone girth, cm	19.5 ± 0.28	1.06	20.7 ± 0.36	0.98	19.95 ± 0.33	0.79

The calves bred in our country have been developing well, as at the age of one year their height at the withers is on average 93.2% of the one of the cows, the heights at the back, the loin and the hook bone, respectively 93.4, 95.1 and 95.5%, as it is logical for the younger animals have more convex rump (Table 4). Logically, the calves are also relatively shorter than the cows.

Based on the measured straight length and the chest girth, using the formula of Truhanovski (Nikolov et al, 2012), with correction index 1.8-2, the calculated live weight of the calves is 360-400 kg, which is within upper recommended limits.

The animals have been developing proportionately. The parameters of the chest are around 90% of the ones for the adult animals. The pelvis is more closed. The bones are well developed.

At the age of two years, the heifers have the proportions of the adult cows (Table 5). The heights at the withers, at the back, the loin, the hook bones, at the tail setting and at the rump are respectively 97.8, 96.6, 97.4, 97.9, and 99.5%, of the ones of the cows. The relative parameters of the lengths are also similar – for the oblique length – 93.2%, and for the straight one – 93.7%. The chests are well developed, as the

Table 4. Exterior measurements of female calves of the Limousin breed at the age of 1 year (N-15)

Trait	LS ± SE	SD	min	max
Height at the withers, cm	126.5 ± 1.24	4.42	116	134
Height at back, cm	126.9 ± 1.34	4.07	117	133
Height at loin, cm	131.9 ± 1.40	5.03	121	139
Height at the hook bone, cm	134.3 ± 3.13	5.17	122	141
Height at tail setting, cm	133.5 ± 1.39	5.38	122	141
Height at rump, cm	120.0 ± 1.25	4.89	110	128
Oblique body length, cm	149.1 ± 2.32	9.03	126	158
Straight body length, cm	111.8 ± 1.69	5.50	102	121
Chest length, cm	80.8 ± 1.94	6.62	74	97
Chest width, cm	43.5 ± 1.01	3.80	36	48
Chest depth, cm	62.1 ± 1.13	3.96	55	66
Chest girth, cm	179.2 ± 2.62	8.50	162	195
Length of rump, cm	52.1 ± 0.94	2.53	46	56
Width of rump behind hips, cm	44.3 ± 1.12	4.27	35	50
Width of rump at hip joints, cm	45.4 ± 0.87	3.39	25	49
Width at the pin bones, cm	13.2 ± 0.43	1.46	11	16
Cannon bone girth, cm	19.00 ± 0.27	0.85	18	20

Table 5. Exterior measurements of Limousin heifers at 2 years of age (N-17)

Trait	LS ± SE	S. D.	min	max
Height at the withers, cm	132.7 ± 2.23	4.03	116	138
Height at back, cm	131.2 ± 2.41	4.97	117	142
Height at loin, cm	135.2 ± 2.52	16.58	121	148
Height at the hook bone, cm	137.5 ± 5.63	13.68	122	153
Height at tail setting, cm	138.6 ± 2.50	4.10	122	150
Height at rump, cm	125.3 ± 2.25	3.60	110	140
Oblique body length, cm	154.7 ± 4.18	7.68	126	175
Straight body length, cm	119.1 ± 3.05	6.06	102	130
Chest length, cm	83.7 ± 3.49	6.58	65	97
Chest width, cm	46.3 ± 1.82	3.11	36	52
Chest depth, cm	66.2 ± 2.04	3.75	55	74
Chest girth, cm	189.2 ± 4.71	9.26	162	205
Length of rump, cm	54.0 ± 1.69	3.66	46	60
Width of rump behind hips, cm	49.6 ± 2.02	3.41	35	57
Width of rump at hip joints, cm	46.7 ± 1.57	2.58	25	53
Width at the pin bones, cm	14.7 ± 0.78	1.49	11	25
Cannon bone girth, cm	19.26 ± 0.49	1.01	18	22

separate parameters are from 95 to 99% from the one ones of the cows. The rump is well developed.

Between the age of one and two years, the height at the withers has increased with 6.19 cm on average and at the hook bone with 3.26 cm, which leads to a decrease in the size gain. The heights at the back and the loin of the 2-year-old animals are respectively 3% and 2% higher compared to the one-year-olds. There is a more significant increase in the lengths – by 4% for the oblique length and by 7% for the straight body length, the widths – 7% for the chest width, 12% for the width of the rump behind hips and the depths – 6% depths of chest, which is in unison with the classical postulates for the growth and development of herbivores (Nikolov et al., 2012).

The fast development of the heifers is the reason for the animals we have measured between of 3 and 7 years of age to not be reliably different in exterior measurements (Table 2). Significant but without clear trend for a change are only the height of the back, the length of the rump and its width behind hips, as in this case, age/origin interaction cannot be excluded. Despite the lack of differences, additional studies are necessary for the determination of the age of growth completion of the Limousin cows. In this way, the parameters of the primiparous cows, established by Gorinov and Lidji (2016) are significantly lower than the ones we have established. Since for the two studies the animals were imported from different countries and in different period, it is possible that through the last years the farmers have started importing larger animals, which is not considered an advantage for the Limousin breed.

A number of studies show that larger cows have lower effectiveness due to the higher cost for maintenance of the body weight (Barham et al., 2019), but according to Johnson et al. (2019) no single breed or size that are the most effective for all conditions. To assess the effectiveness of the particular system, it is necessary thorough analysis the environment, market, production purposes.

In accordance with the developed scale for the shape of the body of beef cattle, developed at the University of Wisconsin, USA (FSBK, 2019), based on the height of the hook bone, the Limousin breed, bred in our country, falls into the category of late maturing breeds, but it is closer to the lower range of the group. This type of animals is characterized with maximum height and length, elongated forms with potential for rapid growth to advanced age and ability to be fattened to higher body weight (over 450 kg).

Conclusion

The Limousin cows bred in Bulgaria are relatively large: height at withers is 135.7 ± 1.52 cm on average, the oblique body length is 166.0 ± 1.78 cm, the chest girth is 199.1 ± 2.03 cm, the range of cannon bone is 19.96 ± 0.18 cm. The animals are deep, wide, with well-developed chest and rump, with relatively thin bones.

The origin has significant effect on the exterior parameters of the cattle, as the cattle imported from Austria are the largest. The cattle imported from France and those born in Bulgaria are not significantly different in their external dimensions.

The Limousin calves develop well in Bulgaria, as at the age of one year they reach 93-95% of the height of the body of mature body size, 90% of the oblique body length and the chest girth, 95% of the girth of the cannon bone. At the age of two years, the stated parameters are respectively 97-99% of the height, 93% of the oblique body length, 95% of the chest girth, and 96% of girth of the girth of cannon bone.

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Received: July, 31, 2019; *Accepted:* August, 5, 2019; *Published:* October, 31, 2019