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STUDY ON IMPROVING BEEF PRODUCTION THROUGH INDUSTRIAL CROSSING

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Abstract

This paper aimed to assess the improvement of beef production using industrial crossbreeding. The research was conducted on 101 individuals allotted in four groups, L1-Romanian Spotted cattle (RS) – control 1; L2 Limousine (L) x Romanian Spotted cattle; L3-Romania Black and White cattle (RBW) – control 2 and L4-Limousine x Romanian Black and White cattle. Body development of half-bloods from experimental groups was higher than the maternal breeds, showing pronounced aptitudes for beef production, especially in L x RS cross, which performed a body weight by 18 months old of 689.37 kg (+14.36% compared to maternal breed). An obvious improvement of beef yield was registered also in L x RBW group (603.13 kg live weight at 18 months old, +15.38% vs. the maternal breed). BS x L half-bloods had an average daily gain above 975 g, fitting into the beef morphological type. In the study, we found a good ability of body development for half-bloods and a pronounced heterosis effect compared to maternal races.

Key words: *cattle, production, beef, improvement, half bloods.*

INTRODUCTION

Beef production could be regularly improved by increasing weight at slaughter and adjusting husbandry technological factors or through genetic-breeding methods, such as crossing with beef specialised breeds (Maciuc et al., 2018; Ujică et al., 2011; Phocas et al., 2005).
The use of first generation crossbreeds between bulls from beef breeds with cows from mixed and dairy breeds for increasing beef production has expanded in all advanced countries in the world, due to the achieved economic efficiency. Cows with low milk production, with udder diseases, reformed cows after 1st calving that do not interest in selection and dairy cows that constitute a surplus for the farmer are used as maternal receptacles in such crossings (Barwick et al., 2005; Crump et al., 1997; Pribylova et al., 2004).
The economic advantages of first generation crossbreeds are: better ability of gaining weight; the use of the heterosis effect to achieve high weight gains; higher beef production, in terms of yield and quality indexes (Maciuc et al., 2018; Vidu et al., 2013; Ujică et al., 2011).
Worldwide, the trends are to increase beef production, both quantitatively (especially in those countries with food deficit) and qualitatively (goal to be achieved by the countries more developed economically).
Most research, such as those in Denmark on crossbreeds between dairy and beef races, demonstrates the possibility of improving meat production by obtaining commercial hybrids with beef attributes (Bignon, 2008; Eriksson et al., 2004, Onaciu et al., 2016).
Out of the numerous data presented in the scientific literature it rise the importance and utility of crossings of local breeds with beef specialized breeds, due to the occurrence of the heterosis effect which is translated into: better feed conversion, especially of forages and pasture species; increasing of the average daily gains by 6 to 10%; increasing of the live weight at slaughter and, subsequently, of the dressed percentage value; higher participation of great quality meat in carcass and better protein levels in the proximate beef composition; better caloric value of carcasses; inheritance of carcass quality traits via paternal genetic lines; exceptional potential in genetic combinability of Simmental breed in crossings with beef

breeds; overall improvement of meat yields, vitality and resistance against various diseases.

Also, there are in the national herd many cows with hypermetric body development. It is also known that the beef oriented breeds are better in energy conversion therefore in overall energetic balance of the production ecosystem, hence they do not require high amounts of feed to convert into the main product, due to 8-12% lower feed conversion ration value, in comparison with the non-beef oriented breeds (Agus et al., 2018; Aiello et al., 2018; Disking et al., 2018; Kelsey et al., 2018; Koenig et al., 2018; Li et al., 2018; Vendramini et al., 2018; Zhao, 2019).

Usage of industrial crossings, as way to amplify the heterosis effect remains one of the main challenges in cattle farming, worldwide. The perpetual importance of this technique is given by the permanent need in increasing the beef yield (Chilimar, 2006; Nelson et al., 2018; Onaciuc et al., 2016; Walmsley et al., 2018).

The research is part of the current national guidelines in order to know the effect of industrial crosses with specialized breeds and improve beef production in cattle using the biological potential that we have (Vidu et al., 2013; Fogh, 2007).

MATERIALS AND METHODS

In our country, it has been undertaken relatively little research to test the combining capacity of indigenous breeds (Romanian Spotted, Black and White Romanian, Brown of Maramureş, Pinzgau of Transylvania, Grey Steppe) with beef specialized, especially with modern breeds.

That's why we wanted to know the combinative capacity of the national breeds with Limousine breed and to use for Tow-breed Terminal Cross cows from Romanian Spotted and Black and White Romanian races.

Adult cows with unaltered reproductive function and without incidents in precedent parturitions were chosen to become crossbreeds' mothers. They were inseminated with semen from valuable bulls belonging to beef breeds.

Milk yields of mothers cows were good in Romanian Spotted breed and very good in Black and White Romanian Breed, being able to provide enough milk to the suckling calves, that induced them a better body development.

One hundred and one individuals were used as biological material, assigned to four groups: L_1 Romanian Spotted – control group; L_2 Limousine x Romanian Spotted; L_3 Black and White Romanian – control group and L_4 Limousine x Black and White Romanian. Subsequently, the issued crossbreeds were raised separately in accordance with their age group (calving, 6 months, 12 months, 18 months) within the same farming conditions, the half-intensive production system.

The diets were balanced accordingly, to comply the average daily gains requirements in each specific rearing stage and age maintenance needs of the breeding stock.

The feed rations were formulated in accordance with the existing feed raw matters, in order to cover the energy, protein, minerals and vitamins needs and were provided to both crossbreeds' groups and to pure breeds-control groups.

Within our research, the assessment of beef production was measured through fattening (growth) indexes, as related to body weight, as well as through the measurements of the main body dimensions, applied in all groups and age categories.

There were carried on weightings and body measurements such as: height at withers, height at hips, body length, depth of chest (heart girth), head length, head width, chest (thorax) circumference, cannon circumference.

Primary acquired data were systematised in a database then statistically processed. The statistical descriptors (estimators) that characterise a normal distribution are represented by both median and mean, as well as by the dispersion indexes, such as the variance, standard deviation of each analysed traits. They were noted with Latin and Greek letters, as following: arithmetic mean ($\overline{X}$), variance (s^2), standard deviation (s), theoretical mean (μ), variance ($ó^2$) and standard deviation (ó).

The S.A.V.C. software package (Statistics, Analysis of Variance and Covariance, 2003) was used to compute the arithmetic mean ($\overline{X}$), standard mean error ($\pm s_{\bar{x}}$), standard deviation (s), coefficient of variation (V %) as well as the significance of the differences between means (ANOVA and *p* values).

Data analysis was correlated with the field observation at farm levels and in accordance with the European Union requirements and normatives.

Due to the real interest manifested by the cattle farmers for the results acquired in the crossbreedings between local Romanian breeds and the two tested beef specialised breeds, the follow-up of the research was to investigate the usage of other beef specialised breeds in crossings, especially in those individual farms from hillous and mountainous areas.

RESULTS AND DISCUSSIONS

The average values and variability of body weight at birth are shown in Table 1.

Analysing body weight at birth, in relation with gender and cross-breeding, revealed that Lx RS half breeds had intermediate average values of 40.83 kg for males and 37.80 kg for females. The average value for both groups was 40.57 ± 0.412 kg.

In the cross-breeding variant of RBWx Limousine, the calves had lower average birth weights than those resulting from the first crossbreeding variant RS x L. RBW breed registered an average weight of 36.76 kg for males and of 35.08 kg for females.

Average value for both (RBW males and females) was 35.34±0.280 kg. Compared to half-breeds F1 L x RS, L x RBW half breed had lower body weight.

Table 1 The mean values and variability of the body weight at birth

Group	Gender	n	$\overline{X} \pm s_{\overline{x}}$	s	V%	Min	Max
L_1 RS	M	14	38.42	-	-	-	-
	F	10	35.73	-	-	-	-
	Total	24	36.52±0.421	2.06	5.58	33	40
L_2 L x RS	M	15	40.83	-	-	-	-
	F	10	37.80	-	-	-	-
	Total	25	40.57±0.412	2.06	5.28	35	42
L_3 RBW	M	15	36.76	-	-	-	-
	F	12	35.08	-	-	-	-
	Total	27	35.34±0.280	1.45	4.07	33	38
L_4 L x RBW	M	13	38.97	-	-	-	-
	F	12	36.56	-	-	-	-
	Total	25	38.09±0.304	1.51	4.08	35	40
Total		**101**	**37,93±0,215**	**2.64**	**6.98**	**33**	**46**

Depending on the crossbreed variant, the ANOVA test indicated very significant differences between the L x RBW group and the RBW group, between the L x RS group. The L x RS half-breeds had an average body weight at birth with 2.08 kg higher then RS breed ($p<0.001$).

Analysing body weight variability at birth, depending on crossbreeding variant we notice that maximum value for standard deviation for total group was 2.06 kg and for coefficient of variance was 5.58%.

Analysing dispersion indices we can conclude that for body weight at birth the groups were homogeneous.

Following body development of experimental groups at 6 months old, 12 months old and 18 months old, there were found the following results: at 6 months old, all males from groups had a body weight above 200 kg, with the exception of the RBW group.

Higher development was noticed in L x RS with an average body weight of 237.53±1.636 kg, followed by L x RBW with an average body weight of 219 kg (tab. 2).

For overall groups, average body weight at 6 months old was 223.74 kg, suggesting thus a good body development.

Table 2. The mean values and variability of body weight at 6 months (males, n=15 per group)

Group	$\overline{X} \pm s_{\overline{x}}$	s	V%	Min	Max
L_1RS	209.57±1.113	4.16	1.98	203	215
L_2 L x RS	237.53±1.636	6.33	2.82	211	262
L_3RBW	188.20±0.932	3.61	1.91	182	195
L_4 L x RBW	219.31±0.536	1.93	0.91	209	230
Total	223.74±1.994	18.38	8.48	182	262

The most significant weight differences were recorded between the RBW group and the L x RS group (49.33 kg) and L x RBW (31.00 kg) half-breeds.

At 6 months old, the groups were homogeneous enough, the standard deviation values being between s = 1.93 kg for L x RBW group and s = 6.33 kg for L x RS group.

The variability amplitude had a minimum limit of 188.20 kg (RBW) and a maximum of 237.53 kg (L x RS). At this age, the average weight on all groups was 223.74 ± 1.994 kg.

For the 12-month age, body weight indices are shown in Table 3.

It was found that the groups L x RS and L x RBW exceeded the weight of 400 kg, while the RS and RBW groups achieved average weights close to the 400 kg threshold.

The weakest body development was found in RBW group, of just 335.14 ± 1.082 kg, much lower than the other experimental groups.
The best body development was achieved for Lx RS, which was 237.53 ± 1.636 kg. Also, the average body weight for all groups studied was 427.68 ± 1.223 kg.
The dispersion indices depict a good homogeneity of all groups, standard deviation values being between 5.17 kg (RBW) and 9.52 kg (L x RS), while the coefficient of variation oscillated between 0.57% (L x RS) and 2.29% (RS).
At 12 months old, L x RS group is ranked first with an average body weight of 463.37 kg, followed by the L x RBW group with 417.38 kg, keeping the same sequence from the previous ages (birth, 6 months).

Table 3 The mean values and variability of body weight at 12 months (males, n=15 per group)

Group	$\overline{X} \pm s_{\overline{x}}$	s	V%	Min	Max
L_1RS	397.36±1.419	9.05	2.29	380	410
L_2 L x RS	463.37±0.652	9.52	0.57	437	446
L_3 RBW	335.14±1.082	5.17	1.55	323	340
L_4 L x RBW	417.38±1.049	6.66	1.72	375	400
Total	**427.68±1.223**	**47.87**	**11.68**	**323**	**498**

The amplitude of variability had the lower limit of 335 kg (RBW) and the upper limit of 463.37 kg (L x RS).
The average values and the significance of differences for the live weight at 18 months old are presented in Table 4.

Table 4 The mean values and variability of body weight at 18 months (males, n=15 per group)

Group	$\overline{X} \pm s_{\overline{x}}$	s	V%	Min	Max
L_1 RS	589.44±1.209	11.72	2.01	568	625
L_2 L x RS	689.37±1.774	8.32	1.26	648	700
L_3 RBW	510.33±1.167	6.500	1.29	488	520
L_4 L x RBW	603.13±1.287	6.468	1.12	565	615
Total	**619.21±1.133**	**8.532**	**1.41**	**488**	**712**

From the comparative analysis of the body weight at 18 months old it was found that the L x RS group achieved the highest weight (689.37 kg) while the L x RBW half-breeds achieve the lowest one (603.13 kg).
Compared with males from maternal breeds, Lx RS and L x RBW half-breeds performed higher weights, with very significant differences as result of ANOVA ($p < 0.001$).
Not significant differences were recorded only between the RS and RBW groups and the Lx RBW half-breeds exceeded the weight of RS males with 13.69 kg.
The largest differences were recorded between the L x RS group and RBW group (179.04 kg), but also between the L x RBW group and RBW group (92.80 kg).
The individual variability in the groups was reduced, the groups being sufficiently homogeneous, as indicated by dispersion indices (s and V%), the maximum standard deviation being recorded for the RS group (s=11.72 kg and V% 2.01).
The maximum variability amplitude was recorded for the L x RS group (689.37 kg) and the minimum for the RBW group (510.33 kg).
Following the presentation of the results on the evolution of body weight from birth to 18 months old, it resulted that half-breeds issuing from RS x Limousine had higher growth energy than the RBW x Limousine half-breeds.
The dynamics of body weight by age and genotype is shown in Figure 1.

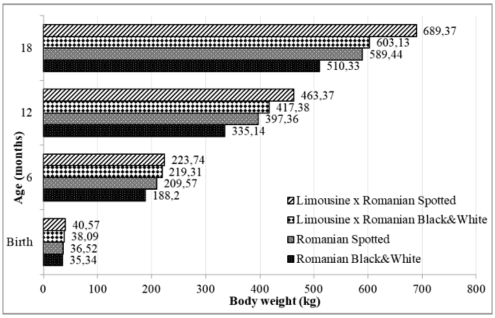

Figure 1. Body weight dynamics, according to age and genotype

In both cases, however, the half-breeds had higher body weights than maternal breeds (RS and RBW), which fully justifies the use of these cross-breeds to improve beef production.
The chart representation clearly highlights the superiority of beef half-breeds as compared to maternal breeds throughout the fattening period.

CONCLUSIONS

Absolute and relative values show that F1 half-breeds calves had better body development at birth compared to maternal breeds (RS and RBW).

The body development of the half-breeds in the experimental groups is higher to the maternal races, highlighting the pronounced skills for beef production, especially in Lx RS half breeds.

Thus, the Lx RS half-breeds achieved the body weight of 689.37 kg, exceeding the maternal breed with 99 kg (14.36%). The RS x L half-breeds achieved an average daily gain of more than 975 g/day, fitting into the morphological type of meat.

An obvious improvement in beef yield was also achieved in the case of L x RBW half-breed, which achieved at 18 months old a body weight of 603.13 kg, higher than the native breed with 92.80 kg (15.38%).

The economic advantages of industrial crosses result from the better ability of the half-breeds to fattening and use the heterosis effect to achieve high weight gains, as well as by higher indexes in the quantity and quality of beef.

The main conclusion is that all tested breeds could be successfully used in crossing. Those cows having a higher body development could be inseminated with sperm produced by Charolaise and Limousine bulls, while those with lower development are to receive Hereford sperm, knowing that interracial hybrids with Charolaise and Limousine tend to develop more muscle mass during fetal stage, inducing, therefore, possible calving issues.

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