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Effect Of Ecological Type In Hereford Cattle On Growth Performance And Carcass Traits.

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ABSTRACT

The objective of this study was to compare the growth performance and carcass traits of three ecological types of Hereford bull-calves and heifers (Urals, Canadian and Urals cross, Canadian). Canadian and Urals cross was obtained by artificial insemination of local dams with Canadian semen. Canadian group of animals was obtained by Canadian embryos transplantation to local dams. Cattle from all experimental groups (n = 20 in each) were reared under the equal management system during the all control period. Bulls from each group were slaughtered at the age of 20 months. Cows were slaughtered after weaning their progeny approximately at the age of 30 months. Live weight and average daily gains of animal were measured in definite periods of life and the post-slaughter analysis were conducted. Canadian bull-calves and heifers were significant heavier (P < 0.05 – 0.001) compared with Urals analogues in the most periods. The significantly highest average daily gains (P < 0.01 – 0.001) for the whole period of control growth (0 - 15 months) were noted in imported groups of bull-calves and heifers. Canadian × Urals crosses showed intermediate values of growth rate. Regarding post-slaughter analysis, Canadian bull-calves significantly exceeded (P < 0.05, P < 0.01) for hot carcasses weight compared their contemporaries. Significant difference for dressing percentage was noted between local and imported genotype of bull-calves (P < 0.05). Canadian cows significantly exceeded local animals for live weight before slaughter (P < 0.01) and hot carcass weight (P < 0.01). The accumulation of visceral fat had not differ significantly both in bull-calves and cows groups. The significant differences for net meat weight were achieved between local and imported genotypes (P < 0.05). The meat yield had no significant source of variation. The combination of the Canadian and Urals genotypes had improving effect on productivity of Hereford cattle in Russia.

Keywords: beef cattle, Hereford, ecological type, growth performance, carcass traits.

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INTRODUCTION

In the second half of the XX century a significant number of English and Canadian Herefords were imported in the USSR in order to create a base of specialized beef cattle breeding and development of crossbreeding program. The maximum delivery were found in the period from 1955 to 1975. A total of 7756 animals were imported, 30% of them were addressed in Siberian herds.

Currently, Russia has formed several sub-populations of Hereford cattle. The largest of them are Ural and Siberian. Following the demand for competitive beef cattle with high growth performance and dressing percentage, the breeders began developing interbreed types and lines of Herefords with superior productive traits and well adapted for breeding in certain conditions on the base of these sub-populations (Kayumov *et al.*, 2009).

Further improvement of Hereford continues with increase in growth performance, frame size and maternal ability. This became possible due to the wide use of imported genetics through the importation of semen, embryos and live cattle. Mainly import have taken place from Canada because of the similarity in climatic conditions (Morgan *et al.*, 2013). However, little information is available about growth and carcass traits of Canadian Hereford compared with local population of Herefords under the certain condition of South Ural. The objective of this study was to characterize ecological types of Hereford cattle (Urals, Canadian and their cross) for growth performance and carcass traits in South Ural conditions.

MATERIALS AND METHODS

Animals and conditions

Hereford cows and sires belonging to Canadian (C) and Urals (U) ecological types produced animals (bull-calves and heifers) for this study. The mating schemes were: the first – Urals dams mated with Urals sires, the second – Urals dams × Canadian sires by the artificial insemination method and the third Canadian dams and sires by embryos transfer method. The material of study comprised 60 bull-calves and 60 heifers divided in three groups (20 individuals each) according parentage:

- straight Urals (U)
- Canadian and Urals cross (C × U)
- straight Canadian (C)

Experimental animals in all groups were derived from the same herd in South Ural region (Chelyabinsk region) of Russian Federation in December 2009 to January 2010. During the pre-weaning period, male and female calves were raised under the same conditions with their mothers. Animals being fed entirely on maternal milk and grazing on the same pastures during May to August. The growing ration that was fed from birth until pasture period included mainly maternal milk with additional feeding by hay, barley and oilcake.

Calves of all experimental groups were weaned in August at an average age of 205 ± 30 d. Young bulls were moved in test station and were allocated according their parentage in different pens holding twenty animals each equipped with drinkers and feed-bunks. They were managed in a test station condition until 20 months of age (a slaughter age). The growing ration included hay, corn silage, barley and oilcake during the all control period. The quality of all types of feeds were evaluated as good and very good.

Heifers of all ecological types were placed at the common pen equipped with drinkers and feed-bunks until the beginning the pasture period (May). The ration included the similar feeds as their male analogues. Heifers were artificial inseminated by Polled Hereford bulls of Canadian selection at approximately 15 months of age (March). Synchronization of estrus was carried out using progesterone drugs. Calving commenced at the end of December 2011 and continued until the end of February 2012. Calving took place in individual boxes, and animals remained there ten days with their progeny. They joined with common experimental herd after this period. Milk period continued until their progeny reached 205 days old. The first calving cows of all groups were run in the same pastures with their progeny. Cows were pastured after weaning until the slaughter age (approximately 30 months) was reached.

Young bulls from each group were slaughtered at the age of 20 months. Carcasses were dressed and halved into half-carcasses, chilled for 24 h at a temperature of around +4°C and weighted. The similar procedures were carried out with cows at the age of 30 months. Right half carcasses were dissected with the requirements of Government Standard of Russian Federation (GOST 31797-2012). Net meat, total bones, cartilage and tendons were weighted during half-carcasses dissection.

Traits Evaluated

Growth traits included live weight at different ages: birth, eight months, yearling and fifteen months. Average daily gain (g/d) was also calculated for different periods. Carcass traits included hot carcass weight, carcass dressing percentage, internal fat weight, slaughter weight and slaughter yield.

Statistical analysis

Data were processed with one-way analysis of variance with using Statistica 9.0 software Generalized Linear Models procedures (Statsoft Inc., 2009). Least squares differences and probability values for differences were calculated using Tukey's test.

RESULTS

The effect of animals' ecological type on live weight for particular periods are reported in Table 1.

Table 1: Least square means and standard errors of the live weights of experimental animals by periods of life, kg (LSM ± SE)

Age, months	Ecological type		
	U	C × U	C
Bull-calves			
Birth	26.6 ± 0.17^{b}	26.2 ± 0.14^{b}	29.0 ± 0.63^{a}
8	230.0 ± 3.78^{b}	236.4 ± 3.79^{ab}	243.1 ± 3.13^{a}
12	358.8 ± 4.50^{b}	371.1 ± 6.58^{b}	407.3 ± 6.98^{a}
15	435.3 ± 5.09^{b}	454.1 ± 6.52^{b}	494.1 ± 9.18^{a}
Heifers			
Birth	24.5 ± 0.45^{b}	25.7 ± 0.52^{b}	27.7 ± 0.63^{a}
8	221.0 ± 2.82^{b}	232.9 ± 4.15^{ab}	238.8 ± 5.40^{a}
12	305.1 ± 3.53^{b}	327.1 ± 4.13^{a}	329.7 ± 6.79^{a}
15	366.6 ± 3.76^{b}	383.4 ± 4.61^{b}	403.6 ± 7.27^{a}

$^{a\text{-}b}$ Within a row, means without a common superscript letter differ (P < 0.05)

The highest birth weight were found in Canadian type of animals, both in bull-calves and heifers groups. Newborn Canadian bull-calves were significantly heavier contemporaries on 2.4 – 2.7 kg (9.02 – 10.27 %; P < 0.001). Analogues in heifers group had also significant advantage by 2.0 – 3.2 kg (7.78 – 13.06 %; P < 0.05, P < 0.001). Body weight in 8 months did not differ significantly (P > 0.05) between bull-calves. However, Canadian heifers had significant heavier live weight over Urals contemporaries by 17.8 kg (8.05 %; P < 0.05). Yearling Canadian bull-calves significantly exceeded two other groups at 36.2 - 48.4 kg (9.75 - 13.49 %; P < 0.001). At the same period, Urals heifers had significantly lower 12 months live weight by 22.0 - 24.6 kg (6.73 - 7.46 %; P < 0.05, P < 0.01). By the end of the control period (15 months of age), the differences in live weight of young bulls increased up to 40.0 – 58.8 kg (8.81 – 13.51 %; P < 0.001) in favor of the Canadian animals, obtained from embryos transfer. Female analogs of origin showed the similar rang in live weight with significant advantage at 20.2 – 37.0 kg (5.27 – 10.09 %; P < 0.05, P < 0.001).

Average daily gain of experimental animals by periods of life are shown in table 2.

Table 2: Least square means and standard errors of the average daily gains (ADG) of experimental animals by periods of life, g / d (LSM ± SE)

Age period, months	Ecological type		
	U	C × U	C
Bull-calves			
0 - 8	837.2 ± 15.32	864.8 ± 15.47	881.3 ± 12.72
8 - 12	1055.7 ± 28.65^{b}	1104.5 ± 42.33^{b}	1345.9 ± 52.81^{a}
12 - 15	840.1 ± 39.87^{b}	911.5 ± 28.42^{b}	953.3 ± 59.71^{a}
8 - 15	963.6 ± 19.96^{b}	1022.1 ± 23.12^{b}	1178.2 ± 36.51^{a}
0 - 15	896.3 ± 11.20^{b}	938.3 ± 14.20^{b}	1020.0 ± 19.57^{a}
Heifers			
0 - 8	808.6 ± 13.05^{b}	852.5 ± 17.19^{ab}	868.7 ± 21.42^{a}
8 - 12	689.8 ± 21.93^{b}	773.0 ± 19.15^{a}	744.8 ± 21.45^{ab}
12 - 15	674.4 ± 28.09^{b}	618.1 ± 49.37^{b}	812.6 ± 23.12^{a}
8 - 15	683.2 ± 16.85^{b}	706.8 ± 20.55^{b}	773.8 ± 12.49^{a}
0 - 15	750.1 ± 8.52^{b}	784.4 ± 10.14^{ab}	824.3 ± 15.56^{a}

$^{a-b}$ Within a row, means without a common superscript letter differ (P < 0.05)

Canadian bull-calves showed the maximum growth intensity in suckling period. They exceeded contemporaries by 16.5 – 44.1 g / d (1.91 – 5.27 %, P > 0.05), but the differences were not significant. Canadian heifers had a significant advantage (60.1 g / d; 7.43 %, P < 0.05) under Urals animals in the same period. The average daily gain increased after weaning in all groups of young bulls. Bull-calves obtained from embryos transfer significantly exceeded animals from other groups on 241.4 – 290.2 g / d (21.86 – 27.49 %; P < 0.001) in the period from 8 to 12 months of age. In contrast, the growth intensity decreased in all groups of heifers. Despite that, the distribution rank for ADG between different groups was preserved. The significant difference (83.2 g /d; 10.76 %, P < 0.05) was registered between crossbred and Urals females. There was no significant source of variation for ADG in the period from 12 to 15 months of age between groups of young bulls. However, Canadian bull-calves had a better hand under contemporaries about 156.1 – 214.6 g / d (15.27 – 22.27 %). The sharp decrease of growth intensity was noted in all ecological types of males. ADG continued to fall in Urals and crossbred groups of heifers in the period from 12 to 15 months of age. In contrast, Canadian heifers had compensated for the losses and accelerated the growth intensity compared the previous period. As a result, they significantly exceeded contemporaries on 138.2 – 194.5 g / d (20.49 – 31.47 %; P < 0.05, P < 0.001). Canadian bull-calves had a significant advantage (156.1 – 214.6 g / d; P < 0.001) for ADG in the period from 8 to 15 months when bull-calves located in test station. The pregnancy from Urals parents had shown the minimum growth intensity. At the same period heifers analogs of origin similarly exceeded animals from other groups on 67.0 – 90.6 g / d (9.48 – 13.26 %; P < 0.05, P < 0.01). In general for the whole period of control growth (0 - 15 months), the lowest growth rate was noted in the group of Urals bull-calves – 896,3 g, which was significantly less than in other groups at 42.0 – 123.7 g / d (4.48 – 12.13 %; P < 0.01, P < 0.001). At the same time, the cross Urals x Canadian showed an intermediate growth rate. In this way, heterogeneous crosses provided the improving effect on average daily gain in live weight. At the same period, heifers, obtained from transfer of Canadian embryos, were significantly superior by 74.2 g / d (9.89 %; P<0,001) relatively to their Urals contemporaries.

Data for carcass characteristics are reported in Table 3.

Table 3: Least square means and standard errors of the slaughter traits of experimental animals, LSM ± SE

Trait	Ecological type		
	U	C × U	C
Bull-calves			
Live weight before slaughter, kg	607.7 ± 5.90^{b}	638.0 ± 7.09^{ab}	661.3 ± 10.87^{a}
Carcass weight, kg	353.0 ± 2.52^{b}	371.3 ± 8.35^{b}	398.3 ± 5.46^{a}
Carcass dressing percentage, %	58.1 ± 0.40^{b}	58.2 ± 0.66^{ab}	60.2 ± 0.31^{a}
Visceral fat, kg	13.7 ± 0.12	15.1 ± 1.10	16.8 ± 1.36
Heifers			
Live weight before slaughter, kg	438.0 ± 10.82^{b}	473.7 ± 11.29^{ab}	514.0 ± 7.23^{a}
Carcass weight, kg	242.7 ± 14.10^{b}	262.0 ± 12.77^{ab}	285.7 ± 7.31^{a}
Carcass dressing percentage, %	55.3 ± 1.82	55.3 ± 1.42	55.6 ± 0.69
Visceral fat, kg	12.3 ± 1.34	12.9 ± 0.68	15.3 ± 0.30

$^{a-b}$ Within a row, means without a common superscript letter differ (P < 0.05)

Canadian bull-calves were significantly heavier their Urals contemporaries before slaughter on 53.6 kg (8.82 %; P < 0.01). As a result, the heaviest carcasses were obtained from imported animals. They significantly exceeded bulls from others groups for hot carcasses weight by 27.0 – 45.3 kg (7.27 – 12.83 %; P < 0.05, P < 0.01). Carcass dressing percentage achieved 58.1 – 60.2 % among all groups of bull-calves. Significant difference for dressing percentage was noted between local and imported genotype at 2.1 % (P < 0.05). The accumulation of internal fat had not differ significantly. Some advantage was established in Canadian bull-calves who exceeded two other groups at 1.7 - 3.1 kg (11.26 – 22.63 %).

There were no significant differences for slaughter traits between crossbred heifers and other groups. Canadian heifers significantly exceeded local animals for live weight before slaughter by 76.0 kg (17.35 %; P < 0.01) and hot carcass weight by 43.0 kg (17.71 %; P < 0.01). There were no significant source of variation among experimental heifers for dressing percentage and content of internal fat.

Data concerning morphological composition of half-carcasses are presented in Table 4.

Table 4: Least square means and standard errors of the half-carcasses' morphological composition of experimental animals, LSM ± SE

Trait	Ecological type		
	U	C × U	C
Bull-calves			
Half-carcass weight, kg	174.7 ± 1.94^{b}	184.8 ± 5.63^{ab}	197.5 ± 2.18^{a}
Meat weight, kg	147.5 ± 3.06^{b}	155.5 ± 5.40^{ab}	167.4 ± 2.30^{a}
Meat yield, %	84.4 ± 0.81	84.1 ± 0.51	84.7 ± 0.34
Bone weight, kg	24.8 ± 0.81	26.2 ± 0.90	27.1 ± 0.60
Bone yield, %	14.2 ± 0.61	14.2 ± 0.44	13.7 ± 0.35
Connective tissue, kg	2.5 ± 0.33	3.1 ± 0.24	3.1 ± 0.07
Connective tissue yield, %	1.4 ± 0.20	1.7 ± 0.18	1.6 ± 0.02
Meat yield per 1 kg of bones, kg	5.97 ± 0.327	5.94 ± 0.210	6.19 ± 0.181
Heifers			
Half-carcass weight, kg	120.3 ± 6.93^{b}	130.0 ± 6.49^{ab}	141.6 ± 3.47^{a}
Meat weight, kg	95.13 ± 5.982^{b}	103.03 ± 5.414^{ab}	112.90 ± 3.23^{a}
Meat yield, %	79.03 ± 0.416	79.24 ± 0.300	79.72 ± 0.577
Bone weight, kg	22.40 ± 0.889	24.10 ± 1.060	25.60 ± 0.802
Bone yield, %	18.66 ± 0.323	18.55 ± 0.301	18.09 ± 0.579
Connective tissue, kg	2.77 ± 0.145	2.87 ± 0.088	3.10 ± 0.058
Connective tissue yield, %	2.31 ± 0.134	2.21 ± 0.061	2.19 ± 0.018
Meat yield per 1 kg of bones, kg	4.24 ± 0.096	4.27 ± 0.084	4.42 ± 0.177

$^{a-b}$ Within a row, means without a common superscript letter differ (P < 0.05)

Compared with the Urals bull-calves, Canadian individuals had significant heavier cold half-carcasses by 22.8 kg (13.05 %, P < 0.05). As a result of the heaviest carcasses, the maximum of meat in absolute figures was collected when Canadian bull-calves were slaughtered. The significant difference was achieved between local and imported genotypes (19.9 kg, 13.49 %; P < 0.05). The meat yield had no significant source of variation. Particularly interesting the lowest meat yield in crossbred group compared to the other groups. We had not found any significant differences for inedible parts of half-carcasses. The bone weight was the highest in Canadian bull-calves. In addition, they had the minimum of bone yield compared with the animals from other groups. The highest meat yield and the lowest bone yield had determined the maximum of meat yield per 1 kg of bones in Canadian bull-calves. The advantage was 0.22 – 0.25 kg (3.69 – 4.21 %; P > 0.05) compared to the contemporaries.

There was significant difference in cold half-carcasses weight between Canadian and Urals cows by 21.3 kg (17.71 %; P < 0.01) in favor of the imported animals. Minimum of meat were collected from half-carcasses of local Hereford cows. They significantly conceded Canadian females by 17.77 kg (15.74 %, P < 0.05). Meat yield, bone weight and yield, connective tissue weight and yield were not significant differs between studied ecological types. Some advantages for bone and connective tissue weight were found in Canadian group compared with contemporaries. At the same time, Urals cows characterized by the highest bone and connective tissue yields. The half-carcasses from Canadian cows were profitable in respect with meat yield per 1 kg of bones. They exceeded contemporaries by 0.15 – 0.18 kg (3.51 – 4.25 %), but the differences were not significant.

DISCUSSION

Nowadays Hereford cattle breeders have to search the best choices for their breeding programs for creating a stable demand for genetics. It is dictate the necessity for different types of Hereford cattle (Dickenson, 1984; Dzhulamanov *et al.*, 2010; Dubovskova *et al.*, 2010).

Blott *et al.* (1998) found a significant genetic diversity between Canadian and British Herefords. They reported that Herefords from Canada were more homozygous compared with other populations of Herefords.

Live weight of beef cattle is largely the result of breed, breeding value, biological type, growth rate, body size and body conformation (Chambaz *et al.*, 2003; Alberti *et al.*, 2005; Nogalski *et al.*, 2012). In addition, Ronchietto (1993) reported that agro-ecological region determines 6.8% and 3.4% of the variation (P < 0.01) in pre-weaning and weaning live weight in beef cattle respectively. Dooley *et al.*, (1982) also informed that bioregion had a significant (P < 0.05) source of variation on weaning live weight. In its turn, Tredeen *et al.* (1982) found that pre-weaning growth rate of calves varies by 10 - 13% between regions of rearing (P < 0.001). Mwandotto *et al.* (1983) observed that location of birth had a significant influence on post weaning growth (18 months) of different cattle breed types.

In this study, experimental animals of different ecological types were reared in similar feeding conditions during the entire test period. Because the progeny from parents of different ecological types varied in genetic potential for growth, the live weight of animals obtained by transplantation of Canadian embryos were heavier in every period of live than the local and crossed offspring. The values related to dynamics of live weight available in this study were similar to those of earlier experiments (Ernst *et al.*, 2010; Gerasimov *et al.*, 2011; Litovchenko *et al.*, 2015). These data convincingly prove that outstanding growth performance of Canadian Herefords can be used in improving breeding programs in South Ural feeding and environment conditions. Xie *et al.* (2012) observed the highly significant differences between the imported (Limousin and Simmental) and the local Chinese breeds for final body weight and average daily gain. They considered that high genetic potential for growth of imported beef cattle can be maintained under typical Chinese feeding conditions.

Post weaning average daily gain is a measure of growth in beef cattle (Casas and Cundiff, 2006). Myers *et al.* (1999) and Mir *et al.* (1999) reported that average daily gain of different ecological types of beef cattle had significant source of variation. We obtained similar results in this study. Canadian animal from embryos transplantation grew faster (P < 0.05 – 0.001) after weaning. At the same time, there were no significant source of variation for growth during pre-weaning period between cattle with different inheritance.

Differences in growth rate determined by genotype can affect carcass traits in beef cattle (Vieira *et al.*, 2007). The highest hot carcass weights of Canadian bulls and cows in this study might be due to genotype-specific differences in growth rate. Kuber *et al.* (2004) and Wheeler *et al.* (2004) reported that biological type of beef cattle significantly affected carcass weights. In their studies, carcasses from European cattle were heavier than carcasses from animals imported from Japan.

Imported beef cattle significantly differs for dressing percentage compared with local animals (Xie *et al.*, 2012). In present study, Canadian Herefords had a relatively carcass dressing percentage compared with Urals and crossbred genotypes. This was resulted from their lower percentage of feet, head, hide and visceral organs. Bartoň *et al.* (2006) also reported that genotype affected carcass dressing percentage significantly.

There were no statistical differences in meat yield between observed ecological types of cattle in this study, in spite of the highest meat weights obtained in Canadian animals. Minimum of meat was collected in carcasses obtained from Urals animals, which was in agreement with the results of Gerasimov *et al.* (2012).

Given this, using imported genotypes for improvement of local beef cattle should be extended and accepted widely by producers in Russian Federation.

CONCLUSIONS

Breeding value of Hereford cattle in Russia can be optimized by selection and use of imported genetics from countries with well-developed beef production system. Artificial insemination and embryos transplantation contribute prevalence of animals with high breeding value in local herds. Canadian Hereford showed the best growth performance and highest beef productivity compared with Urals contemporaries. Mating the local dams with Canadian sires improves the genetic potential of their progeny combining the best qualities of both parents.

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