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GROWTH AND DEVELOPMENT INDICATORS BY AGE PERIODS OF LOCAL AND CROSSBRED CALVES RAISED UNDER DIFFERENT FEEDING TECHNOLOGIES (TRADITIONAL AND TMR)

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ABSTRACT

The article analyses live weight, absolute gain, average daily gain and relative growth by age periods in local and local×Holstein crossbred calves kept under traditional and TMR (Total Mixed Ration) feeding technologies, based on a study conducted in rural households of the "Tomosha" mahalla, Furqat district, Fergana region. The study was carried out in four experimental groups of 20 head each (I and II — local bull calves and heifer calves aged 6–12 months, fed traditionally and with TMR, respectively; III and IV — local and crossbred heifers aged 12–18 months, fed traditionally and with TMR, respectively). The results showed that live weight and growth rate in the TMR groups were

significantly higher (P>0.95–P>0.999) than in the traditionally fed groups at all age periods, and that crossbred heifers showed higher growth energy than their local counterparts under both traditional and TMR feeding.

INTRODUCTION

The steadily growing demand for livestock products, and especially the need to increase meat productivity, requires improving intensive rearing technologies in cattle breeding on a scientific basis, taking into account the age-related biological characteristics of animals. The calf-rearing period is characterised by a high intensity of metabolism, rapid formation of muscle and bone tissue, and a high capacity to assimilate nutrients; rational use of precisely these biological features makes it possible to obtain high live weight from young cattle within a short time. Therefore, regular biometric monitoring of live weight, absolute and relative growth and average daily gain of calves at different ages, together with a comparative assessment of these indicators across feeding systems, is one of the most reliable ways to determine how efficiently growth proceeds and whether the applied technology is economically and zootechnically justified.

Specific features of cattle keeping in rural households, including an insufficiently developed feed base and rations that are unbalanced in energy, protein and minerals, may prevent animals from fully expressing their genetic potential. Under such conditions, the introduction of total mixed ration (TMR — Total Mixed Ration) technology can help standardise the ration, balance nutrients and more fully meet the physiological needs of the animal. At the same time, it is of particular scientific interest how crossbred offspring obtained by crossing local cattle with the highly productive Holstein breed differ from local animals in growth energy and feed efficiency owing to heterosis.

The aim of this article is to analyse and scientifically evaluate, on the basis of biometric indicators, the age-related growth and development dynamics of local and crossbred bull calves and heifers under traditional and TMR feeding technologies, using field studies carried out within project No. AL-9124093787-R1 (“Development of a technology for intensive rearing of calves for meat using some of their biological characteristics”) implemented by the Research Institute of Livestock and Poultry.

Studies of age-related growth patterns in calves reveal the general biological features of this process. According to U.N. Nosirov (2005; 2011), calf growth gradually slows down with age, while the amount of feed required per additional kilogram of live weight increases: for example, 1–3-month-old calves need on average 3–4 kg, 6-month-old calves 3.5–4 kg, and calves aged 12–18 months 8–10 feed units per 1 kg of live weight gain; the author attributes this to the high

growth energy at a young age and the intensive course of synthetic processes in tissues. I.P. Prokhorov (2009) studied growth and meat productivity of Black-and-White bull calves and their crosses with Hereford and Limousin breeds under intensive rearing and found a higher growth rate in the crossbred offspring. E.I. Saksa, O.E. Barsukova (2010) and L.D. Samusenko (2010) also noted that a decrease in growth rate with age is a general regularity. R.S. Iskhakov, A.M. Belousov and V.N. Krylov (2015), in a comparative study of the growth characteristics of purebred and crossbred bull calves, scientifically confirmed the positive effect of crossbreeding on growth energy — a finding consistent with the superior growth of crossbred heifers over their local counterparts in the present study.

MATERIALS AND METHODS

The research was carried out in 6 rural households located in the "Tomosha" mahalla, Furqat district, Fergana region. Groups were formed from cattle kept in these households, taking into account similarity in age, sex, origin, physiological condition and breed, as well as the feeding method applied. Data from the following four groups were used for the growth indicators analysed in this article:

- **Group I** — 6-month-old local bull calves and heifer calves (20 head in total: 10 bull calves and 10 heifers), fed by the traditional method;
- **Group II** — 6-month-old local bull calves and heifer calves (20 head in total: 10 bull calves and 10 heifers), fed a TMR ration;
- **Group III** — 12-month-old local and crossbred heifers (20 head in total: 10 local and 10 crossbred), fed by the traditional method;
- **Group IV** — 12-month-old local and crossbred heifers (20 head in total: 10 local and 10 crossbred), fed a TMR ration.

The live weight of animals in each group (bull calves at 6, 9, 12, 15 and 18 months and before slaughter; heifers at 6, 9, 12, 15 and 18 months) was determined by individual weighing. Based on the weighing results, absolute gain, average daily gain and relative growth by age periods were calculated using the following generally accepted zootechnical formulas:

Absolute gain: $A = W_2 - W_1$, where A is the absolute gain, W_2 is the final live weight and W_1 is the initial live weight.

Average daily gain: $A = (W_2 - W_1) / t$, where t is the duration of the period, in days.

Relative growth: $K = [(W_2 - W_1) / 0.5 \cdot (W_1 + W_2)] \times 100\%$, where K is the relative growth, W_1 is the initial weight and W_2 is the final weight.

The numerical data obtained were processed biometrically according to the method of E.K. Merkurieva (1970), together with the coefficient of variation (Cv, %) and the level of significance (P according to Student's test: P>0.95; P>0.99; P>0.999).

RESULTS AND DISCUSSION

Growth and development of local bull calves (groups I and II)

According to Table 3.2.1, the live weight of bull calves in group II, fed using TMR technology, was higher at all age periods than in group I fed traditionally.

Table 3.2.1. Growth and development indicators by age periods of local bull calves raised under different feeding technologies (n=20)

Indicator	Group I, 6 months	Group I, 9 months	Group I, 12 months	Group II, 6 months	Group II, 9 months	Group II, 12 months
Live weight, kg ($\bar{X}\pm Sx$)	122.0±4.31	167.0±3.18	221.0±6.18	*130.0±2.48	*174.0±2.50	**238.0±5.20
Cv, %	11.16	6.02	8.85	6.04	4.54	6.90
Absolute gain, kg ($\bar{X}\pm Sx$)	91.0±4.49	45.0±5.53	54.0±8.12	*99.0±2.83	44.0±2.21	**64.0±4.07
Cv, %	15.59	38.83	47.57	9.04	15.86	20.13
Average daily gain, g ($\bar{X}\pm Sx$)	505.6±24.93	500.0±61.40	600.0±90.27	*550.0±15.73	488.9±24.56	**711.1±45.21
Cv, %	15.59	38.83	47.57	9.04	15.86	20.13
Relative growth, %	118.95±4.01	31.42±4.13	27.81±3.93	122.99±2.64	28.93±1.38	31.01±1.61

*P>0.95; **P>0.99; ***P>0.999.

At 6 months of age, the live weight of bull calves in group II was 130.0 kg, which was 8.0 kg or 6.6% higher than in group I (P>0.95). At 9 months the difference was 7.0 kg (4.2%) (P>0.95). By 12 months, the live weight of TMR-fed bull calves reached 238.0 kg, 17.0 kg or 7.7% higher than their traditionally fed counterparts, and the difference was highly significant (P>0.99).

Absolute gain also confirmed the efficiency of TMR technology: in the period up to 6 months, absolute gain in group II was 99.0 kg, 8.0 kg higher than in group I (P>0.95). In the 6–9-month period there was almost no difference between the groups (44.0 and 45.0 kg), whereas at 9–12 months absolute gain in the TMR group was 64.0 kg, 10.0 kg higher than in group I (P>0.99). A similar pattern was observed for average daily gain: up to 6 months, daily gain in group II was 550.0 g, 44.4 g higher than in group I (P>0.95); at 6–9 months the difference was

not significant (500.0 and 488.9 g); and at 9–12 months daily gain in the TMR group was 711.1 g, 111.1 g higher than in the traditional group (P>0.99). In line with the physiological regularity, relative growth declined with age — from 122.99% in group II and 118.95% in group I at 6 months to 31.01% and 27.81%, respectively, at 12 months.

The same trend was observed in local heifers (groups I and II) (Table 3.2.2).

Table 3.2.2. Growth and development indicators by age periods of local heifers raised under different feeding technologies (n=20)

Indicator	Group I, 6 months	Group I, 9 months	Group I, 12 months	Group II, 6 months	Group II, 9 months	Group II, 12 months
Live weight, kg ($\bar{X}$±Sx)	115.0±3.94	158.0±3.26	218.0±7.03	*126.0±2.59	*168.0±2.13	**231.0±3.81
Cv, %	10.83	6.53	10.20	6.49	4.01	5.21
Absolute gain, kg ($\bar{X}$±Sx)	85.0±3.58	43.0±3.47	60.0±6.30	*96.0±2.74	42.0±2.62	63.0±2.88
Cv, %	13.32	25.49	33.20	9.02	19.76	14.46
Average daily gain, g ($\bar{X}$±Sx)	472.2±19.88	477.8±38.55	666.7±70.02	*533.3±15.2	466.7±29.1	700.0±32.0
Cv, %	13.32	25.49	33.20	9.02	19.76	14.46
Relative growth, %	116.44±3.41	31.50±2.84	31.93±2.63	122.29±2.83	28.57±1.69	31.52±1.42

*P>0.95; **P>0.99; ***P>0.999.

At 6 months of age, the live weight of heifers in group II was 126.0 kg, 11.0 kg or 9.6% higher than in group I (P>0.95). At 9 months, live weight in the TMR group was 168.0 kg, 10.0 kg (6.3%) higher than in group I (P>0.95). At 12 months, live weight in group II reached 231.0 kg, 13.0 kg or 6.0% higher than in group I (P>0.99). Absolute gain in the period up to 6 months was 96.0 kg in group II, 11.0 kg higher than in group I (P>0.95); at 6–9 months the difference was negligible (43.0 and 42.0 kg); at 9–12 months absolute gain in group II was 63.0 kg, 3.0 kg higher than in group I. Average daily gain in the period up to 6 months was 533.3 g in the TMR group, 61.1 g higher than in the control group (P>0.95); at 6–9 months it was 477.8 and 466.7 g, respectively; and at 9–12 months it was 700.0 g in the TMR group, 33.3 g higher than with the traditional method. Relative growth reached its maximum in both groups in the period up to 6

months — 122.29% in group II and 116.44% in group I (P>0.95) — and then declined in later age periods in line with physiological characteristics.

Thus, the results for the 6–12-month period showed the advantage of TMR technology in increasing the growth rate and live weight of local bull calves and heifers and in ensuring efficient feed utilisation. In bull calves this advantage was most significant during the intensive growth period of 9–12 months, and in heifers during the period up to 6 months.

Growth of local and crossbred heifers aged 12–18 months (groups III and IV)

Local and crossbred heifers aged 12–18 months were compared for growth indicators in group III (traditional feeding) and group IV (TMR feeding).

Table 3.2.3. Growth and development indicators by age periods of local and crossbred heifers raised under traditional feeding technology in group III (n=20)

Indicator	local, 12 months	local, 15 months	local, 18 months	crossbred, 12 months	crossbred, 15 months	crossbred, 18 months
Live weight, kg ($\bar{X}$±Sx)	218.0±5.78	281.2±5.86	350.9±9.79	**251.5±7.15	**319.2±7.24	**400.1±6.40
Cv, %	8.39	6.59	8.82	9.00	7.18	5.06
Absolute gain, kg ($\bar{X}$±Sx)	–	63.2±4.41	69.7±5.08	–	67.7±3.96	*80.9±4.22
Cv, %	–	22.08	23.03	–	18.49	16.49
Average daily gain, g ($\bar{X}$±Sx)	–	702.0±49.0 (702.2)	774.0±56.4 (774.4)	–	752.0±44.0 (752.2)	*898.9±46.9
Cv, %	–	22.08	23.03	–	18.49	16.49
Relative growth, %	–	25.3 (25.31)	22.0 (22.08)	–	23.7 (23.74)	22.5 (22.49)

*P>0.95; **P>0.99; ***P>0.999.

At all age periods, the live weight of crossbred heifers was higher than that of their local counterparts. At 12 months, the live weight of local heifers was 218.0±5.78 kg and that of crossbreds 251.5±7.15 kg, a difference of 33.5 kg or 15.4% (P>0.99). At 15 months the values were 281.2±5.86 and 319.2±7.24 kg, respectively, a difference of 38.0 kg (13.5%) (P>0.99). At 18 months, local heifers reached 350.9±9.79 kg and crossbreds 400.1±6.40 kg, a difference of 49.2 kg or 14.0% (P>0.99).

In the 12–15-month period, absolute gain was 63.2 kg in local heifers and 67.7 kg in crossbreds, a difference of 4.5 kg. In the 15–18-month period, absolute gain was 69.7 kg in local and 80.9 kg in crossbred heifers; the difference of 11.2 kg was statistically significant (P>0.95). Average daily gain at 12–15 months was 702.2 g in local and 752.2 g in crossbred heifers (difference 50 g), and at 15–18 months 774.4 g and 898.9 g, respectively (difference 124.5 g), which was statistically significant (P>0.95). Relative growth at 12–15 months was 25.31% in local and 23.74% in crossbred heifers, and at 15–18 months 22.08% and 22.49%, respectively. Cv values in all groups ranged from 5.06% to 23.03%; the lowest variation in live weight (Cv=5.06%) was recorded in 18-month-old crossbred heifers, indicating relatively stable growth in this group.

Table 3.2.4. Growth and development indicators by age periods of local and crossbred heifers raised under TMR feeding technology in group IV (n=20)

Indicator	local, 12 months	local, 15 months	local, 18 months	crossbred, 12 months	crossbred, 15 months	crossbred, 18 months
Live weight, kg (X̄±Sx)	252.0±6.32	323.4±6.61	402.7±8.82	**288.1±7.18	**367.2±7.42	**450.6±6.86
Cv, %	7.93	6.47	6.93	7.88	6.39	4.82
Absolute gain, kg (X̄±Sx)	–	71.4±4.32	79.3±4.56	–	*79.1±3.84	83.4±3.91
Cv, %	–	19.15	18.18	–	15.36	14.84
Average daily gain, g (X̄±Sx)	–	793.3±48.0	881.1±50.7	–	*878.9±42.7	926.7±43.4
Cv, %	–	19.15	18.18	–	15.36	14.84
Relative growth, %	–	24.82	21.86	–	24.17	20.40

*P>0.95; **P>0.99; ***P>0.999.

At 12 months of age, the average live weight of local heifers was 252.0±6.32 kg and that of crossbreds 288.1±7.18 kg; the difference of 36.1 kg or 14.3% was highly significant (P>0.99). At 15 months, local heifers weighed 323.4±6.61 kg and crossbreds 367.2±7.42 kg, a difference of 43.8 kg or 13.5% (P>0.99). At 18 months the values were 402.7±8.82 and 450.6±6.86 kg, respectively, with crossbreds exceeding their local counterparts by 47.9 kg or 11.9% (P>0.99).

In the 12–15-month period, absolute gain was 71.4 kg in local and 79.1 kg in crossbred heifers; the 7.7 kg advantage of crossbreds was statistically significant (P>0.95). In the 15–18-month period, absolute gain was 79.3 kg in local and 83.4 kg in crossbred heifers. Average daily gain at 12–15 months was 793.3 g in local and 878.9 g in crossbred heifers, a difference of 85.6 g (P>0.95); at 15–18 months it was 881.1 and 926.7 g, respectively, so the growth rate of crossbreds remained higher in this period as well. Relative growth at 12–15 months was 24.82% in local and 24.17% in crossbred heifers, and at 15–18 months 21.86% and 20.40%, respectively, decreasing in both periods in line with the physiological regularity. The coefficient of variation ranged from 4.82% to 19.15%; in 18-month-old crossbred heifers the Cv of live weight was 4.82%, indicating highly stable growth in this group.

A comparison of Tables 3.2.3 and 3.2.4 shows that live weight and growth rate of both local and crossbred heifers in group IV (TMR) were higher at all age periods than in group III (traditional). At the same time, regardless of the feeding technology, crossbred heifers showed higher growth energy than their local counterparts, indicating that the heterosis effect of crossbreeding, combined with the nutrient balance of TMR technology, created favourable conditions for realising the animals' genetic growth potential.

CONCLUSIONS

The results of the study showed that the feeding technology applied plays a decisive role in the age-related growth and development of local and crossbred bull calves and heifers. In animals of groups II and IV fed using TMR technology, live weight at all studied ages (6, 9, 12, 15 and 18 months) was significantly higher (P>0.95–P>0.99) than in their counterparts in groups I and III fed traditionally. In bull calves this advantage was most pronounced during the intensive growth period of 9–12 months (a difference of 10.0 kg in absolute gain and 111.1 g in daily gain, P>0.99), and in heifers during the period up to 6 months (9.6–6.6% in live weight and 44.4–61.1 g in daily gain).

Analysis of the 12–18-month period showed that, regardless of the feeding technology — both traditional (group III) and TMR (group IV) — crossbred heifers had higher live weight and growth energy than their local counterparts: at 18 months the difference was 49.2 kg (14.0%) in group III and 47.9 kg (11.9%) in group IV, significant at P>0.99 in both cases. The 15–18-month period was the one in which crossbred calves most fully expressed their genetic growth potential in terms of absolute gain and average daily gain.

Thus, TMR feeding technology, regardless of breed, proved to be an effective method for increasing live weight and accelerating growth in calves. Wide introduction of this technology for intensive rearing of calves for meat in rural households, particularly in combination with local×Holstein crossbred offspring, can help obtain high live weight from each animal in a short time and increase the efficiency of meat production.

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