Research Article

Acclimatization Ability and Meat Production of Angus Steers (Australian Selection) Imported in Lower Volga Region of Russia

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Abstract | The article presents the studyof the acclimatization ability of the Angus steers of Australian selection in the conditions of sharply continental climate of the Lower Volga Region of Russia.The steers of Reproduction II have been established to have a more optimal hematologic composition in comparison with their analogsof Reproduction I. Their red blood count was more by 3.5%, hemoglobin by 1.42 and total protein by 1.70%. The album in protein fraction was higher by 7.22%. Bactericidal leukocyte activity of steers of Reproduction II was more than that of steers of Reproduction II by 2.89%, lysozyme activity by 5.39 and phagocytic activity by 2.86%.The steers of Reproduction II were taller in comparison with their analogs, but inferior to them in terms of the measurements that characterize the body width.The growth intensity of the Angus youngsters of Reproduction II was insignificantly higher than that of their peers. With respect to the overall live weight gain, they exceeded the steers of Reproduction I by 4.2 kg and to the average daily gain by 17.5 g.In terms of the hot carcass weight, the control slaughter showed the young cattle of Reproduction II to exceed their analogs of Reproduction I by 6.39 kg or 2.46%, carcass yield by 0.45% and weight of flesh in carcasses by 5.22 kg or 2.46%. The average carcass flesh sample of the Reproduction II steers contained more dry matter by 0.13, protein by 0.07 and fat by 0.05%.The profitability of meat production in the group of cattle of Reproduction II was higher by 2.1%. Thus, the animals successfully passed acclimatization. The results of the research showed that the bulls of the second reproduction have productive qualities that are comparable to those of the I reproduction and even surpass it in linear growth and slaughter.

Keywords | Beef cattle, Acclimatization, Productivity, Meat quality, Profitability

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INTRODUCTION

One of the most important cattle breeding products is beef (Neumann and Lusby, 1986). To increase the production of beef and the diversity of the breed, an important reserve is the development of specialized beef cattle (Sulimova et al., 2016; Gorlov et al., 2017). In recent years, an exchange of breeding cattle, i.e., biological material of promising breeds has been widely practiced between countries (Lund et al., 2014; Ortiz-Colon et al., 2018). In 2012 in the Lower Volga Region of Russia known for a sharply continental climate (cold winter and hot summer), 1200 heads of Angus heifers were imported from Australia. Our studies examined the indicators that characterize the acclimatization ability of steers of two reproductions (Reproduction I included offspring of the livestock imported, Reproduction II wasoffspring of the daughters from the livestock imported).

MATERIALS AND METHODS

To solve the tasks set, a scientific and economic experiment was organized under conditions of the LLC "Don-Agro" in Lower Volga Region of Russia. The samples analysis and data analysis were performed in the laboratory of the Volga Region Research Institute of Manufacture and Processing of Meat-And-Milk Production, Volgograd, Russia.

Animals and Sampling

As mentioned above, Reproduction I included offspring of the livestock imported, Reproduction II was offspring of the daughters from the livestock imported. To conduct an analog method research, 2 groups of Animals at the age of 8 months were formed, 120 animals each. During the daytime, the test animals were grazed in the pasture and at night, they were kept in separate pens in fly camps. The housing conditions and the feed of all of the animals were similar. The rations were developed on the basis of the requirements established (Dunham and Call, 1989; DeLaval, 2001; Kalashnikov et al., 2003) with the "Korm Optima Expert" program complex ("KormOptima", Russia) used. Morphological and biochemical compositions of blood were monitored using URIT-800 Vet and URIT-3020 (URIT Medical Electronic Co., Ltd., China) analyzers (Gorlov et al., 2018). Blood for research was monthly selected from the jugular vein. The state of natural resistance was determined by the tests characterizing the phagocytic activity of the white blood cells (Kondrakhin, 2004; Day and Schultz, 2014).

Exterior parameters, dynamics of live weight gain (including overall live weight gain and average daily weight gain) were estimated in accordance with Government standard (GOST) 25967-83 "Breeding registered cattle. Methods for determination of productive parameters of beef cattle". All applicable international, national, and institutional guidelines for the care and use of animals were followed. Experiments were performed in accordance with the Guide for the care and use of laboratory animals (Guide for the care and use of laboratory animals, 2011).

Raw Meat Samples Evaluation

Slaughter traits were studied using GOST 18157-88 "Slaughtered animal products. Terms and definitions" and GOST R 54315-2011 "Cattle for slaughter. Beef and veal carcasses, semi-carcasses and quarters. Specifications".

Chemical composition of meat was analyzed in accordance with following GOST: 33319-2015 "Meat and meat products. Method for determination of moisture content", 25011-81 "Meat and meat products. Methods of protein determination", 23042-2015 "Meat and meat products. Methods of fat determination", 31727-2012 (ISO 936:1998) "Meat and meat products. Determination of total ash", 23041-2015 "Meat and meat products. Method for determination of oxyproline"; the content of tryptophan was established using a capillary electrophoresis system "KAPEL®-105M" (Lumeks, Russia).

The protein quality indicator (PQI) was calculated using the following formula:

$$PQI = \frac{\text{Tryptophane}}{\text{Oxyproline}}$$

Cost-effectiveness Analysis

The cost-effectiveness of beef production was counted based on the annual actual and intrafarm economic effect and according to Minakov (2015) using the following formulas:

$$\text{Prime cost of 1 kg of gain, €} = \frac{\text{Farm inputs, € per head}}{\text{Total gain, kg}}$$

$$\text{Beef sales proceeds, €} = \text{Total gain, kg} \times \text{Market value of beef, € per kg}$$

$$\text{Profit, €} = \text{Beef sales proceeds, €} - \text{Farm inputs, € per head}$$

$$\text{Profitability level, \%} = \frac{\text{Profit, €}}{\text{Farm inputs, € per head}} \times 100\%$$

Statistical Analysis

The data on different variables, obtained from the experiment, were statistically analyzed by Statistica 10 package (Stat Soft Inc.). The significance of differences between the indices was determined using the criteria of nonparametric statistics for the linked populations (differences with P>0.95 were considered significant: [a]P>0.999; [b]P>0.99; [c]P>0.95; ns = not significant at P<0.95). Student's t-test was applied for the statistical analysis (Johnson and Bhattacharyya, 2010). The mean of a set of measurements was calculated according to the formula: $\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$, where $\bar{x}$ is a mean value; $\sum_{i=1}^{n} x_i$ is the sum of all x_i with i ranging from 1 to n, n is a number of measurements. The residual variation is expressed as a root mean square error (*r.m.s.e.*):

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} \left(x_i - \bar{x}\right)^2}{n-1}}$$

The standard error of mean (*s.e.m.*) was calculated by the formula:

$$s.e.m.(\bar{x}) = \frac{\sigma}{\sqrt{n}}.$$

The reliability of a sample difference (*Student's t-distribution*) was estimated by the test of the difference validity, which is the ratio between the sample difference to the non-sampling error. The test of the difference validity was determined by the formula:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{s.e._1^{\,2} + s.e._2^{\,2}}} \geq t_s \;(d.f. = n_1 + n_2 - 2),$$

where t is a Student's t-distribution; $(\bar{x}_1 - \bar{x}_2)$ is a difference of the sample mean measurements; $\sqrt{s.e.m._1^{\,2} + s.e.m._2^{\,2}}$ is a sample difference error; $s.e.m._1$, $s.e.m._2$ is a non-sampling error of the sample statistics compared; t_{st} is a standard criterion according to the t-Table for the probability threshold preset depending on degrees of freedom; n_1, n_2 is a number of measurements in the samples compared; *d.f.* is a degrees of freedom for difference of two mean measurements.

RESULTS AND DISCUSSION

One of the parameters characterizing the state of the animal's organism in acclimatization is its hematological composition (Danicke et al., 2016; Levakhin et al., 2017). Our study has shown that in blood of the steers ofReproductions I and II, the concentrations of erythrocytes and hemoglobin were within the physiological norm and varied insignificantly. So, in terms of the erythrocyte concentration, the difference between the steers of Reproductions I and II was 0.30-10[12] per L or 3.51% (ns) and of hemoglobin 1.8 gper L or 1.42% (ns) in favour of the steers of Reproduction II.

The blood of the youngsters of Reproduction II contained more leukocytes at significant difference. The content of total protein in blood serum was higher in steers of Reproduction II than in their peers of Reproduction I by 1.39 g per L or 1.70% (P>0.999) (Table 1). The album in fraction of proteins that positively correlates with meat production was higher in the blood serum of youngsters of Reproduction II by 2.69 g per L or 7.22% (P>0.999), respectively.

The markers of the animal's adaptive ability can be indicators of natural resistance, such as bactericidal, lysozyme and phagocytic activities and phagocytic capacity (Scharf et al., 2007; Gorlov et al., 2016). The research study has shown that the steers of Reproduction II had higher indices of natural resistance at insignificant difference. So, the bactericidal activity of their leukocytes was higher than that of their analogs of Reproduction I by 2.89% (P>0.999), lysozyme activity by 5.39 (P>0.999) and phagocytic activity by 2.86% (P>0.999) (Table 2).The phagocytic number of steers of Reproduction II was higher than that of their peers Reproduction I by 0.35 (P>0.999), the phagocytic capacity was more by 2.10 thousands microbial bodies or 86.85% (P>0.999). With respect to the indices of the phagocytic index, the superiority of the steers of Reproduction II over their peers of Reproduction I was 0.44. The data obtained indicate a higher natural resistance of the steers of Reproduction II in comparison with Reproduction I.

Table 1: Hematologic indices of Animals

Index	Reproduction				
	I (n = 120)		II (n = 120)		
	mean	s.e.m.	mean	s.e.m.	P*
Erythrocytes, 10^{12} L^{-1}	7.69	0.15	7.96	0.17	1.19[ns]
Leucocytes, 10^9 L^{-1}	7.58	0.19	7.31	0.13	1.17[ns]
Hemoglobin, g L^{-1}	126.7	2.70	128.5	3.02	0.44[ns]
Total protein, g L^{-1}, incl.:	81.77	0.19	83.16	0.21	4.9[a]
albumins, g L^{-1}	37.26	0.16	39.95	0.25	9.06[a]
globulins, g L^{-1}	44.51	0.21	43.21	0.17	4.81[a]
Calcium, mol L^{-1}	2.53	0.05	2.64	0.06	1.41[ns]
Phosphorus, mol L^{-1}	1.54	0.04	1.58	0.03	0.8[ns]
Carotene, mol L^{-1}	1.56	0.05	1.71	0.04	2.34[b]

*Note: a = P>0.999; b = P>0.99;c = P>0.95 compared with data on the Reproduction I; ns = not significant at P>0.05

Table 2: Natural resistance indices of Animals,%

Index	Reproduction				
	I (n = 120)		II (n = 120)		
	mean	s.e.m.	mean	s.e.m.	P*
Bactericidal activity	41.72	0.54	44.61	0.43	4.19[a]
Lysozyme activity	29.80	0.31	35.19	0.26	13.32[a]
Phagocytic activity	35.17	0.42	38.03	0.37	5.11[a]
Phagocytic number	2.26	0.05	2.61	0.04	5.47[a]
Phagocytic capacity (thous. microbial bodies)	24.18	0.35	26.28	0.31	4.49[a]
Phagocytic index	4.37	–	4.81	–	–

*Note: a = P>0.999; b = P>0.99;c = P>0.95 compared with data on the Reproduction I; ns = not significant at P>0.05

Compared measurements of exterior parameters showed that the differences between the steers of Reproductions I and II were mostly insignificant. So, in terms of the height at withers, the steers of Reproduction II surpassed the peers of Reproduction I by 0.7 cm or 0.62% (P>0.95), oblique body length by 1.5 cm or 1.16% (P>0.999) and oblique lion length 0.4 cm or 0.86% (ns), but were inferior with respect to the width of chest by 0.4 cm or 0.95% (ns) and-width at hook bones by 0.3 cm or 0.65% (Table 3). Their insignificant superiority has been established also in terms of width of lion and thurls. Consequently, the steers of Reproduction I were more wide-bodied in comparison with the peers of Reproduction II, whereas the Reproduction II steers were taller with a longer trunks. This conclusion was confirmed by the values of the body build parameters. So, in comparison with Reproduction I, the parameter of length of the legs was larger in steers of Reproduction II by 0.70, the lengthiness of the body by 0.61,but the chest parameter was less by 0.22, blockiness by 2.45 and massiveness by 1.98 (Table 4).

Table 3: Measurements of exterior parameters of Animals at 16 months, cm

Index	Reproduction				
	I (n = 120)		II (n = 120)		
	mean	s.e.m.	mean	s.e.m.	P*
Height at withers	113.60	0.28	114.30	0.20	2.03[c]
Height at hips	115.70	0.34	116.10	0.26	0.93[ns]
Oblique body length	129.40	0.21	130.90	0.37	3.53[a]
Chest girth	173.20	0.67	172.00	0.52	1.41[ns]
Pastern girth	17.20	0.07	17.20	0.05	0[ns]
Width of chest	41.90	0.20	41.50	0.15	1.6[ns]
Chest depth	65.20	0.25	64.80	0.19	1.27[ns]
Oblique loin length	46.50	0.37	46.90	0.24	0.91[ns]
Width at hook bones	46.30	0.17	46.00	0.23	1.04[ns]
Width of loin	19.20	0.09	19.00	0.12	1.33[ns]
Width at thurls	45.60	0.06	45.40	0.19	0.29[ns]

Note: a = P>0.999; b = P>0.99;c = P>0.95 compared with data on the Reproduction I; ns = not significant at P>0.05

Table 4: Body built parameters of Animals

Index	Reproduction	
	I (n = 120)	II (n = 120)
Length of the legs	42.61	43.31
Lengthiness of the body	113.91	114.52
Chest	64.26	64.04
Blockiness	133.85	131.40
Overgrowth	101.85	101.57
Massiveness	152.46	150.48
Narrowquarters	41.47	41.30

Some researchers believe that the most objective parameter of the acclimatization ability of animals is their productivity (Blanc et al., 2006; Mulliniks et al., 2016).The study has shown that the experimental steers in both groups had high productivity with the difference in the live weight gain between the steers of the two reproductions to be insignificant. However, there was an insignificant tendency of the live weight excess in steers of Reproduction II. So, with respect to the live weight, the differences between the groups varied from 1.0 to 5.6 kg in different age periods (Table 5). In terms of the overall live weight gain for the period of growth from 8 to 16 months of age, the difference in favour of the steers of Reproduction II was 4.2 kg (ns), and the average daily gain of live weight was higher by 17.5 g (ns).

Table 5: Live weight gain of Animals, kg

Age, months	Reproduction				
	I (n = 120)		II (n = 120)		
	mean	s.e.m.	mean	s.e.m.	P*
8	231.2	2.62	232.6	2.38	0.4[ns]
10	290.3	2.76	292.2	3.41	0.43[ns]
12	356.1	3.12	358.3	3.62	0.46[ns]
14	420.0	2.60	421.0	3.91	0.21[ns]
16	477.1	3.45	482.7	3.77	1.10[ns]
Overall live weight gain	245.9	2.19	250.1	1.68	1,52[ns]
Average daily weight gain	1024.6	11.72	1042.1	10.30	1,12[ns]

*Note: a = P>0.999; b = P>0.99;c = P>0.95 compared with data on the Reproduction I; ns = not significant at P>0.05

The slaughter indices of Angus steers of different reproductions was studied with respect to the control slaughter results when they reached the age of 16 months. The lifetime evaluation of steers selected for the control slaughter (15 animals in each group) showed that all of them had high finish. At the age of 16 months, the pre-slaughter weight of the youngsters of Reproduction II was greater than that of the peers of Reproduction I by 7.53 kg or 1.66% (Table 6). In terms of the weight of hot carcasses, the steers of Reproduction II surpassed the peers of Reproduction I by 6.39 kg or 2.46% (P>0.95), respectively, and the carcass yield by 0.45%. The internal slaughter fat in the body of the steers of Reproduction II was higher than that of their peers by 0.71 kg or 4.60% (P>0.95). Due to the heavier carcasses and greater weight of internal slaughter fat of the steers of Reproduction II, the slaughter weight was greater by 7.10 kg or 2.58% (P>0.95), respectively, and the slaughter yield was higher by 0.55 %. The flesh weight in carcasses of the steers of Reproduction II was more than that of their peers by 5.22 kg or 2.46% (P>0.95) with the flesh yield and fleshing index in carcasses to differ insignificantly. The analysis of the average flesh sample from the experimental steers indicated no significant changes in the chemical composition of beef from steers of Reproduction II. The dry matter content in their meat increased by 0.13% (ns), protein by 0.07 (ns) and fat by 0.05% (Table 7). All the differences did not exceed the sampling error. A similar trend was also observed in the chemical composition of the Longissimus muscle. The research has established no significant difference in the amino acid composition of the Longissimus muscle.

Table 6: Slaughter indices and morphological composition of carcasses of Animals (n = 15)

Criteria of slaughter quality	Reproduction				
	I (n = 15)		II (n = 15)		
	mean	s.e.m.	mean	s.e.m.	P*
Pre-slaughter weight, kg	454.31	3.61	461.84	3.24	1.55ns
Weight of hot carcass, kg	260.00	2.04	266.39	2.01	2.23c
Carcass yield, %	57.23	–	57.68	–	–
Weight of internal slaughter fat, kg	15.45	0.18	16.16	0.23	2.43c
Fat yield, %	3.40	–	3.50	–	–
Slaughter weight, kg	275.45	2.29	282.55	2.14	2.26c
Slaughter yield, %	60.63	–	61.18	–	–
Weight of chilled carcass, kg	258.10	2.01	264.32	1.98	2.11c
Flesh weight, kg	212.05	1.63	217.27	1.76	2.18c
Flesh yield, %	82.16	–	82.20	–	–
Weight of bones, kg	40.57	0.43	41.66	0.52	1.61ns
Bone yield, %	15.72	–	15.76	–	–
Weight of tendons, kg	3.48	0.14	3.39	0.17	0.41ns
Tendons yield, %	2.12	–	2.04	–	–
Fleshingindex	5.23	–	5.22	–	–

*Note: a = P>0.999; b ⁼ P>0.99;c = P>0.95 compared with data on the Reproduction I; ns = not significant at P>0.05

The calculation of economic efficiency has found that during the period of the experiment, the live weight gain of the steers of Reproduction II was more than that of Reproduction I by 4.2 kg, while the feed costs per 1 kg of the gain were less by 0.1 EFU (energetic feed unit). The production costs for the experimental groups of steers were equal (Table 8). In comparison with the Reproduction I, the sales proceeds from the Reproduction II amounted to 319.7 EUR, which was more by 5.4 EUR. The advantage of the received profit contributed to the fact that the profitability of beef production exceeded the same parameter in Reproduction I by 2.1%. The average values were calculated as economic indicators up to spring 2018, when the RUR/EUR exchange rate was 70.4.

Table 7: Chemical composition of meat

Component	Reproduction				
	I (n = 15)		II (n = 15)		
	mean	s.e.m.	mean	s.e.m.	P*
Average sample					
Moisture, %	67.30	0.14	67.17	0.14	0.66ns
Dry matter, %, incl.:	32.70	0.14	32.83	0.12	0.71ns
protein	18.97	0.11	19.04	0.08	0.52ns
fat	12.76	0.06	12.81	0.09	0.46ns
ash	0.97	0.01	0.98	0.01	0.71ns
Longissimus muscle					
Moisture, %	76.91	0.15	76.80	0.16	0.50ns
Dry matter, %, incl.:	23.09	0.15	23.20	0.16	0.50ns
protein	19.86	0.12	19.91	0.15	0.26ns
fat	2.25	0.04	2.30	0.03	1.00ns
ash	0.98	0.01	0.99	0.01	0.71ns
Tryptophan, mg%	451.67	1.56	449.89	0.98	0.97ns
Oxyproline, mg%	63.19	0.42	62.75	0.37	0.79ns
PQI	7.15	–	7.17	–	–

*Note: a = P>0.999; b ⁼ P>0.99;c = P>0.95 compared with data on the Reproduction I; ns = not significant at P>0.05

Table 8: Economic efficiency of breeding of Angus steers from Australia. The average values calculated as economic indicators up to spring 2018, the RUR/EUR exchange rate was 70.4.

Index	Reproduction	
	I	II
Total gain, kg	245.9	250.1
Feed costs per 1 kg of weight gain, EFU	6.9	6.8
Production costs, EUR	245.79	245.79
Prime cost of 1 kg of gain, EUR	1.00	0.98
Beefsalesproceeds, EUR	314.36	319.73
Profit, EUR	68.57	73.94
Profitability level, %	27.9	30.0

*Note: EFU = energetic feed unit

Thus, the Angus steers of Australian selection successfully got acclimatized to the conditions of the sharply continental climate of the Lower Volga Region of Russia. The steers of Reproduction II did not reduce their productive qualities and surpassed their analogs of Reproduction I with respect to the linear growth and slaughter indices.

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CONFLICT OF INTEREST

Authors declare that they have no conflict of interest.

AUTHORS CONTRIBUTION

Ivan Fiodorovich Gorlov, Aleksandr Sergeevich Filatov: Study conception and design.
Dmitrii Aleksandrovich Randelin, Klavdiia Vladimirovna Ezergail: Measurements, Acquisition and Analysis of data.
Yuri Dmitrievich Danilov, Elena Yurievna Zlobina: Interpretation of data and Drafting of manuscript.
Aleksei Nikolaevich Sivko, Baatr Kanurovich Bolaev, Aleksandr Petrovich Kokhanov: Critical revision.
All authors read and approved the final manuscript.

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