



The Physiological Status of Acclimatized Simmental Cattle of the Austrian Selection in the Biogeochemical Conditions of the Lower Volga Region

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To cite this article:

Vorobyov Vladimir, Vorobyov Dmitry, Polkovnichenko Andrey, Safonov Vladimir. The Physiological Status of Acclimatized Simmental Cattle of the Austrian Selection in the Biogeochemical Conditions of the Lower Volga Region. *American Journal of Agriculture and Forestry*. Vol. 6, No. 6, 2018, pp. 198-207. doi: 10.11648/j.ajaf.20180606.17

Received: September 17, 2018; **Accepted:** October 29, 2018; **Published:** November 26, 2018

Abstract: The Lower Volga region, including Astrakhan, Volgograd and Saratov regions of the Russian Federation, is characterized by a deficit of iodine, selenium and cobalt in the main components of biogeocenoses. In 2000-2016 in soil, plants, water, organs and tissues of ruminants (total 2911 samples), selected in the Astrakhan region, the atomic adsorption spectrophotometry (Hitachi 180-50, Japan) was used to determine the content of manganese, cobalt, zinc, copper, selenium, iodine, calcium, phosphorus. In addition to iodine, selenium and cobalt deficiency, low copper (from 1.1 to 19.0 mg/kg of dry matter) and molybdenum (within 0.2 ± 12.8 mg/kg of dry matter) were found in the plants of the region. In the hay of natural lands an increased content of calcium and phosphorus was found – 2.6 and 1.2 times higher compared to the recommended norms. In the studied water samples the excess of hydrochemical parameters on hardness – in 4.4 times, magnesium content – 2.4 times, chlorides – 1.4 times, and the presence of ammonia salt was established. The current biogeochemical situation in Astrakhan region is stressful for Simmental cattle imported from Austria, where the climate and composition of plant feed is different. To assess the physiological status of imported animals 5 different age groups of Simmentals were selected 10 heads in each: 1-4 months old calves, bulls on fattening, heifers and cows. The hematological parameters, alkaline reserve, total calcium content in the blood plasma (serum), inorganic phosphorus, vitamins A, E, ascorbic acid, total protein, total lipids, cholesterol, glucose, adrenocorticosterone, cortisol, thyroxine, diene conjugates, malonic dialdehyde, Schiff bases, catalase activity, superoxide dismutase and glutathione peroxidase in blood, peroxide resistance of erythrocytes were determined in the animals. The number of erythrocytes in the blood of cows exceeded the upper limit of the physiological norm by 17.2%, the concentration of hemoglobin – by 42.1, in all observed animals there was a shift of leukoformula to the right. Biochemical parameters of blood in all age groups of cattle were on the lower limit of norm (vitamin A, total protein, alkaline reserve, and the antioxidant enzymes activity) or below norm (glucose, thyroxine, total calcium, inorganic phosphorus), that along with an imbalance in the system “lipid peroxidation-antioxidant protection” was the evidence of incomplete adaptation to new climatic and geochemical conditions of the environment. Changes in the endocrine and metabolic profile of animals are considered as the main reasons for reducing their milk production and incomplete use of genetic potential.

Keywords: Trace Elements, Simmental Cows, Peroxidation, Physiological Status

1. Introduction

When animals acclimatize, physiological and biochemical blood parameters respond most quickly and subtly to the

changed geochemical conditions, that also depends on the breed, age, physiological state and nature of various stress

factors [1-5]. The complex functional changes, caused by the acclimatization of Simmental cattle in the biogeochemical region of the Lower Volga have not been previously studied. The purpose of this study was to study the physiological status of cattle of the Simmental breed of Austrian selection, brought to the region of the Lower Volga.

2. Materials and Methods

2.1. Biogeochemical Analyses

To determine the biogeochemical situation of the experimental sites in a number of areas of Astrakhan, Volgograd and Saratov regions by the method of V. V. Kovalsky [6], soil, plant, water, organs and tissues of ruminant animals were sampled in the period 2000-2016. 2911 biological samples were selected and investigated for the content of trace elements (Mn, Co, Zn, Cu) by atomic absorption spectrophotometer "Hitachi 180-50". Selenium was determined with using the fluorimeter EF-ZM according to the method of V. V. Ermakov [7], and iodine-rodamine-nitrite method GOST 28-458-90 [7].

2.2. Animal Materials and Study Design

In order to study the physiological status of imported and acclimatized animals and their adaptive qualities, 5 groups of different age Simmentals were selected, 10 heads in each group (1-4 months old calves, bulls on fattening, heifers and cows).

2.3. Biochemical and Hematological Analyses of Blood Samples

Corpuscles and hemoglobin probed in the auricle blood using Hematology analyzer Mythic-18 (Switzerland). Total Ca and inorganic plasma phosphorus were determined photometrically ("Specord S300UV VIS" - Germany) by titration [7]. Antioxidant vitamin E was studied in blood serum using liquid chromatography ("Minichrom" with a scanning UV detector), vitamin A was investigated on S. L. Tailor with co-authors and the content of ascorbic acid – on A. T. Petrova with co-authors [7].

Total protein was assessed in blood serum refractometrically (RL, Poland), glucose – by color reaction with ortho-toluidine, alkaline reserve – by diffuse method, carotene – by conventional methods [7]. Diene conjugates (DC) – spectrometrically on UV absorption spectra of serum lipid solution at 233 nm [7], malonic dialdehyde (MDA) was studied on M. Miechra with coauthors [8]. Schiff base - type compounds in plasma were determined on A. V. Arkhipov [8] on the spectrofluorometer F-4010 (Hitachi, Japan) at a wavelength of 200 nm.

The catalase activity was studied by the method of M. A. Korolyuk [8], superoxide dismutase (SOD) – by the ability to

compete with nitroblue tetrazolium for superoxide anions by S. I. Chevri [8], glutathione peroxidase (GPO) – on R. Paglian Valentine [8], and peroxide resistance of erythrocytes (PRE) was evaluated on A. A. Pokrovsky [8] using the spectrophotometer SF-46. Total lipids were examined using a set of reagents "BIOTEST" of "LACHEMA" company, and total cholesterol – using a set of "CHOLESTEROL – VITAL 12" produced by OOO "VITAL DIAGNOSTICS SPb". Adrenocorticosterone (ACTH) and cortisol in blood were determined by solid-phase immunoenzyme method using "Biomerica. ACTH ELISA" tests with the analyzer "Elisys Quattro" (Germany). Thyroxine (T4) in blood serum was studied using the analyzer "Uniplan" by immunoenzyme analysis method.

2.4. Statistical Analysis

Statistical processing of the research results was performed using computer programs Microsoft Excel 97 Pro and Statistica 6.0. The results were expressed as the arithmetic mean \pm standard error of the mean. To determine the degree of reliability Student's t-test were used, at the level of significance $p < 0.05$.

3. Results

According to obtained data, soils (0-25cm) of Astrakhan, Volgograd and Saratov regions contain an average of 7.1 ± 0.95 mg/kg of cobalt, and nickel, iodine, selenium, copper, molybdenum, zinc and manganese, respectively: 5.21 ± 0.05 ; 0.04 ± 0.001 ; 0.02 ± 0.0005 ; 0.02 ± 0.001 ; 16.6 ± 0.98 ; 2.1 ± 0.25 ; 46.3 ± 1.21 and 148.2 ± 9.77 mg / kg [1].

It is known that the content of trace elements in plants depends on their content in the soil, on the number of mobile forms, on the species and physiological characteristics of plants and the climate of a particular area [6]. It was found that the content of trace elements in forage plants varies quite widely. Peas, wheatgrass, nettles, maize and compound feed are rich in manganese (Table 1). Comparing obtained results with the literature data [6, 9], it can be said that the plant feed of the region under study contains sufficient amount of manganese.

Taking into account the informative material, it can be argued that the majority of forage plants contain insufficient amounts of cobalt, in comparison with similar plant feeds of the Black earth "reference" region [6, 9].

The copper content in different plants ranges from 1.1 to 19.0 mg / kg of dry matter. This is due to the types of soil and species characteristics of plants with different ability to assimilate trace elements. Corn silage, Bromus inermis, alfalfa hay, nettle and corn are rich in copper. In most studied forages of the Lower Volga region, the copper content is within the lower level of the "norm" [9], and in a number of plants even lower [1, 6].

Table 1. The content of trace elements in plants of Astrakhan, Volgograd and Saratov regions mg / kg (1998-2013).

Name of plants	Elements					
	Mn	Co	Cu	Mo	Ni	Se
1	2	3	4	5	6	7
Lucerne	28.0±3.15	0.6±0.01	10.0	0.20	0.54	1.07
Meadow grasses	47.0±2.93	0.1±0.004	5.0	0.74	1.4	0.02
Legumes and gramineae	50.0±1.11	0.26±0.0009	4.3	0.10	1.7	0.62
Red clover	85.0±1.14	н/б	4.1	3.3	3.7	1.44
Elymus trachycaulon	100.0±3.38	2.2	7.0	5.3	3.5	0.01
Agropyron	50.0±0.97	н/б	4.5	2.9	9.0	0.02
Delphinium	13.2±0.71	н/б	5.1±0.6	0.59	2.6	-
Bromus inermis	71.0±0.98	0.02	3.1	3.9	2.7	0.008
Phleum	90.0±5.39	0.08±0.002	4.5	1.3	3.2	0.11
Sudangrass	55.0±3.33	н/б	4.2	2.1	1.1	0.03
Poa pratensis	71.0±4.06	0.04±0.001	3.8	0.07	3.6	0.005
Oat hay	51.0±4.03	сл	5.6	0.44	0.12	0.06
Oat straw	23.0±1.12	сл	2.3	0.58	0.65	0.03
Green oat	61.0±2.39	н/б	5.3	0.23	1.6	0.04
Barley straw	24.0±0.99	сл	2.3	0.19	1.8	0.01
Atriplex	17.0±1.4	н/б	4.1±0.5	-	5.6	0.09
Manna trees	3.9±0.9	-	5.5±1.0	3.0	0.64	-
Nettle	130.0±8.84	сл	6.4	3.3	1.6	0.88
Common wormwood	62.0±2.51	-	7.2	1.8	2.2	1.99
Spiny cocklebur	17.0±0.8	-	2.7±0.07	11.2±1.3	0.1	-
Corn	190.0±10.3	0.01	15.0	1.0	1.0	0.02
Corn leaf	13.8±1.11	0.04	2.1	1.8	2.2	1.54
Corn silage	90.0±2.22	2.0±0.06	17.1	0.65	0.84	0.01
Sunflower seed silage	81.0±3.43	0.4	10.5	0.73	1.1	1.05
Potato tops	20.0±1.06	н/б	7.3	1.7	1.2	0.03
Cabbage	59.0±3.55	н/б	7.1	1.9	3.2	0.02
Barley-grain	8.3±0.37	0.9	5.6	0.02	0.04	-
Oat-grain	23.0±1.22	0.8	7.2	0.03	0.33	0.04
Wormseed wallflower	14.0±0.72	н/б	6.4	0.019	0.19	-
Rye-grain	29.0±1.5	1.01	2.5±0.04	0.68	1.0	-
Common purslane	10.0±0.58	н/б	4.3	0.53	6.1	0.01
Peas	150.0±6.21	1.01	7.5	8.6	2.1	2.19
Shepherd's purse	16.2±1.2	0.01	11.7±0.8	1.2	9.0	0.008
Yellow sweet clover	13.2±0.05	сл	7.8±0.4	0.17	0.8	1.85
Common reed	14.8±0.12	0.03	8.1±0.02	0.83	1.7	0.28
Bromus inermis	13.7±1.2	0.01	10.4±0.9	0.63	0.9	0.007
Mixed fodder	149.0±150	1.8±0.05	7.4-26	1.64-3.98	5.2	1.03
Astragalus	87.0±5.93	4.6±0.17	21.3	12.8	2.1	12.6

The analysis of plants showed that the content of molybdenum in them varies within 0.2±12.8 mg/kg of dry matter. Astragalus and spiny cocklebur contain this metal a lot. Taking into account the diverse composition of the animals' diet, molybdenum can be considered to be in geochemical conditions of the Lower Volga region in quantities that are not able to have a toxic effect on the animal body. The same can be said about nickel. Its amount was in the range of 0.04-9.0 mg/kg of dry matter. The highest content of this element was noted in the agropyron, shepherd's purse - 9 mg/kg, mixed fodder - 5.2 and in Astragalus (2.5 mg/kg).

The soils and plants of Astrakhan and Volgograd regions have not been studied for selenium content, which is a necessary and important physiological element in animal nutrition before the present work [1]. Studies showed that the gross content of trace elements in soils and plants varies within a very wide range (Figure 1). In May-June, the level of selenium in plants is higher than in autumn. This is

explained by the fact that in the summer months there is the most intensive growth of plants and a significant migration of trace elements from the soil to the plants [9]. Most of selenium was found in the soil in May – 0.051±0.006 mg/kg and the lowest amount was in autumn – 0.024±0.003 mg/kg. The average concentration of selenium in the soil of the studied region was 0.038 ± 0.004 mg/kg.

These studies show that in the studied samples of most plants the level of selenium is lower than the "optimal" one, the amount of which is 0.05 mg/kg [1, 9]. The selenium content in plants of the Lower Volga region ranges from 12.6±0.2 to 0.008±0.002 mg/kg of dry matter.

Analyzing the obtained data (Table1, Figure 1) it can be argued that in the studied soils and plants growing on them, the amount of selenium is definitely less than in their analogues from the "reference" Black earth region and loamy steppe soils [1, 6], which makes using this element in animal husbandry of the Lower Volga region necessary and promising.

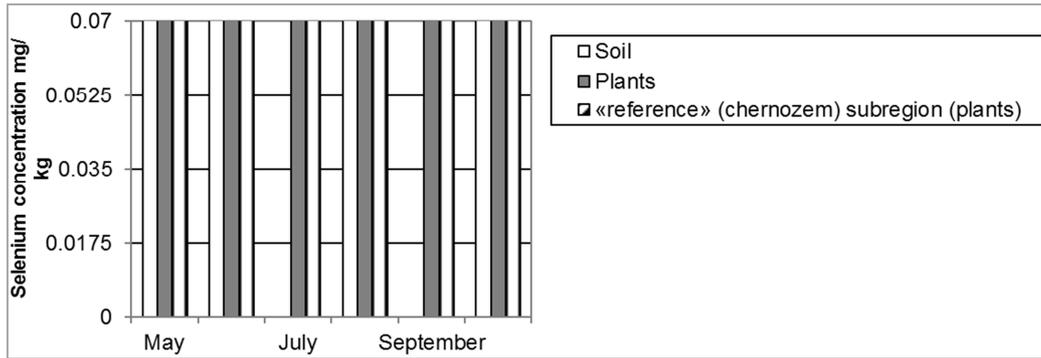


Figure 1. Average level of selenium in soils and plants of Astrakhan, Volgograd and Saratov regions.

Inadequate feeding is the cause of much functional pathology. The level of prevention of violations development of physiological functions of organs and tissues depends on the usefulness of feeding, contributing to the increase of resistance and immunobiological reactivity of the animal organism. It is undeniable that only a healthy animal can be a

highly productive manufacturer of physiologically high-quality products. Meanwhile, the completely natural process of transfer of production to private (farm) basis, which covered all branches of animal husbandry, is inevitably associated with unusual and often extreme (stress) conditions of exploitation of farm animals.

Table 2. Content of trace elements in the diet of Simmental cows by seasons.

Seasons of the year	Name of feed	Elements in mg/kg dry matter				
		Manganese	Cobalt	Copper	Molybdenum	Selenium
autumn	Corn silage	90.0	2.7	19.0	0.65	0.24
	Alfalfa hay	28.0	0.6	10.0	0.20	0.8
	Straw	24.0	no	2.3	0.19	w
	Mixed fodder	490.0	1.8	74.0	0.70	1.11
winter	Corn silage	32.0	2.1	11.0	0.45	1.16
	Alfalfa hay	20.0	0.6	9.0	0.21	0.9
	Straw	25.0	no	1.8	0.19	w
	Mixed fodder	490.0	1.8	74.0	0.70	1.62
spring	Corn silage	32.0	1.4	9.0	0.42	0.91
	Alfalfa hay	18.0	no	7.0	0.19	0.8
	Straw	14.0	w	1.6	0.18	0.22
	Mixed fodder	490.0	1.8	74.0	0.70	2.4

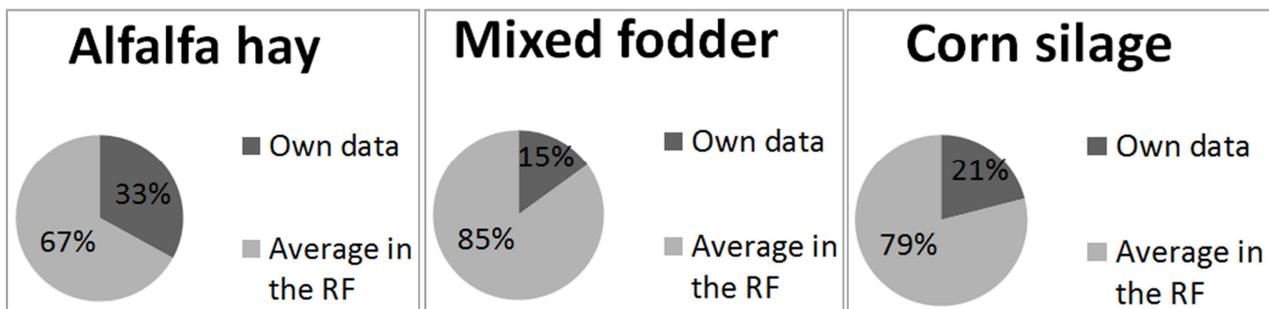


Figure 2. The content of carotene in the feed of the Simmental cows diet.

At shipping from Europe and acclimatization of simmentals in geochemical conditions of arid climate in Astrakhan region the stress load on the body of the animal increases dramatically, resulting in reduced resistance, the function of the major organs and systems disrupts, the nature of physiological functions of the organism and in general the functioning and the integrative function of productivity changes. Often, the basis of this lie in metabolic disorders (ketosis, osteodystrophy, hypo microelement), the etiology of

which is errors in feeding. The correct balanced feeding serves as a reliable preventive measure and contributes to the effective restoration of physiological processes in the body [2].

Considering the qualitative composition of feed and water of Astrakhan region (Figure 2-4) a significant deficiency of carotene in all the samples can be noted. It was revealed in the hay from natural land excess ($p < 0.05$) of calcium content in 2.6 times, and in the hay of alfalfa – in 1.7 times, phosphorus – in 1.2 times relative to the average standards [1, 2].

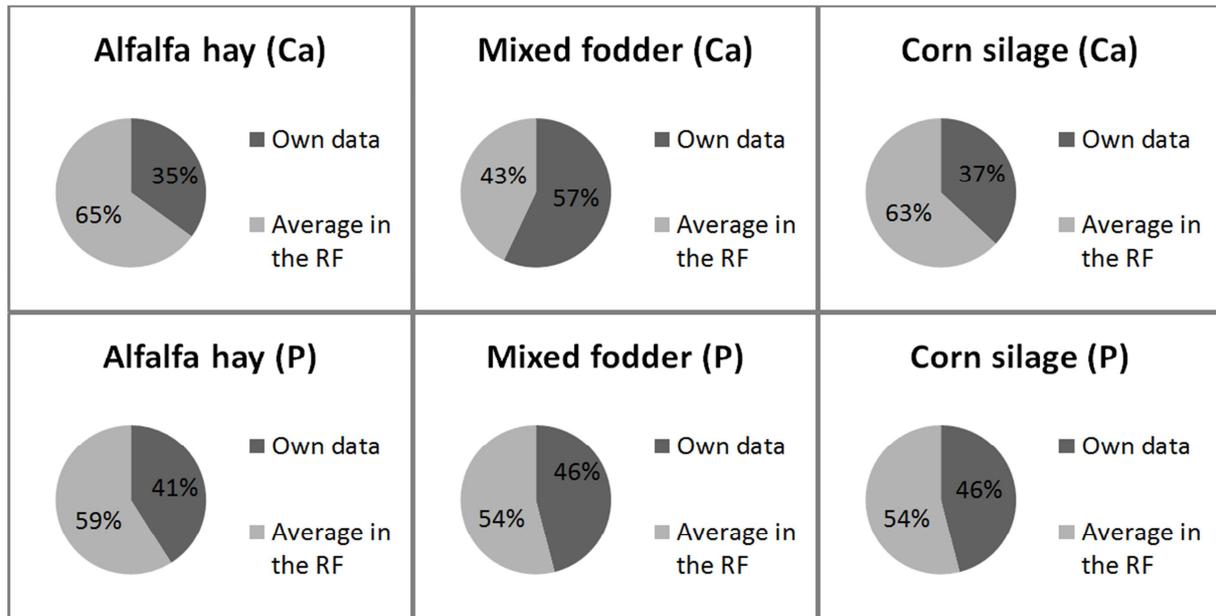


Figure 3. Calcium and phosphorus content in the feed of Simmental cows.

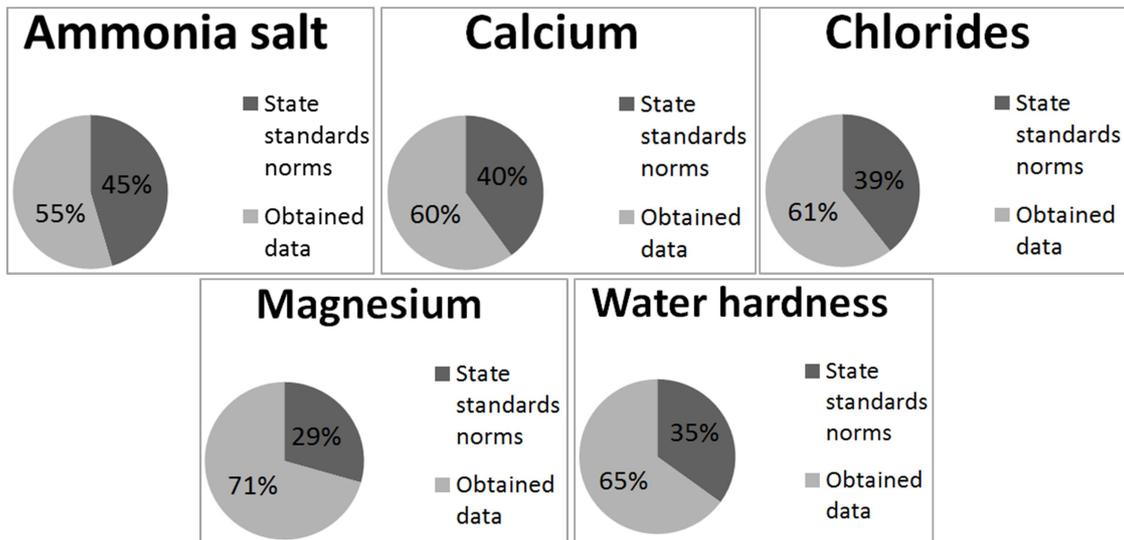


Figure 4. Chemical indicators of water in the Astrakhan region farms.

In the studied water samples the excess of hydrochemical parameters in relation to the available standards on hardness – in 4.4 times, magnesium – in 2.4 times, chlorides – in 1.4 times, and the presence of salt ammonia in the water under study was established. All the above is the defined indicators of the biogeochemical environment in the Lower Volga region, including Astrakhan region, where the described experiments were conducted [1, 6], which serve as the stress factors to the Simmental animals imported into the region from Austria, where there is another climate, and other forage in Alpine meadows, and other qualities of it.

It was found that the number of red blood cells and the percentage of hemoglobin in the blood of monthly Simmental calves is higher ($p < 0.05$) than in the blood of animals of other age groups (10.8 ± 0.12 million/ μ l and 14.6 ± 0.24 g/l). And in Simmental bulls on fattening the number of red blood cells and

the percentage of their hemoglobin saturation is greater than that of heifers by 12.3% and 3%, respectively. The number of erythrocytes in the blood of acclimated cows of Simmental breed exceeds the upper limit of physiological norm by 17.2%, the amount of hemoglobin - by 42.1%. This is also probably due to the peculiarities of the geochemical environment of the pasture ecosystems in Astrakhan region [1].

Analysis of white blood parameters in ontogenesis showed that the number of leukocytes decreases with age. The greatest number of them is observed in 4 -5 months old calves, which is 2 times higher ($p < 0.05$) than their content in the blood of cows (Figure 5).

Lymphocytosis was revealed in Simmental calves. Moreover, the number of lymphocytes in animals reaches 69.8%. After the rise there is their slow decline with age (up to 6 months). This can be explained by high growth rates in

early ontogenesis and puberty, as lymphocytes, in addition to the protective function, play their well-known role in the absorption and synthesis of proteins. The number of neutrophils in the blood of animals increases with age. The presence of immature forms of neutrophils in the blood of young animals was revealed, which leads to a shift in the leukoformula to the left. Obviously, at the beginning of ontogenesis the hematopoietic organs do not function fully yet that neutrophils have time to mature in them (Figure 6).

In the early period of ontogenesis (up to 1 year), age-related changes in the number of eosinophils were clearly expressed and observed a hypoeosinophilia, and at 1.5 year-

old age, a sharp jump-like increase in the number of eosinophils was revealed in the calves on fattening during all further ontogenesis. In cattle, the nuclear shift in the norm is about 1/3 [7], the increase in the shift of the leukoformula to the right (neutrophilia) with the age of the animals occurs against the background of the biogeochemical situation of Astrakhan region (deficiency of iodine, selenium, cobalt) and the probable hypofunction of the thyroid gland on the basis of iodine deficiency, as well as certain changes in lipid peroxidation (LPO), due to the low level of selenium and the reactions of the antioxidant system of animals in the process of acclimatization of imported Simmentals.

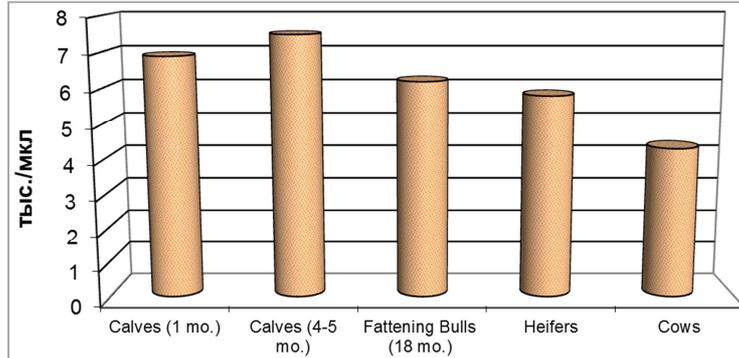


Figure 5. Changes in the number of leukocytes in the blood of different age groups of Simmentals in the biogeochemical conditions of the LowerVolga.

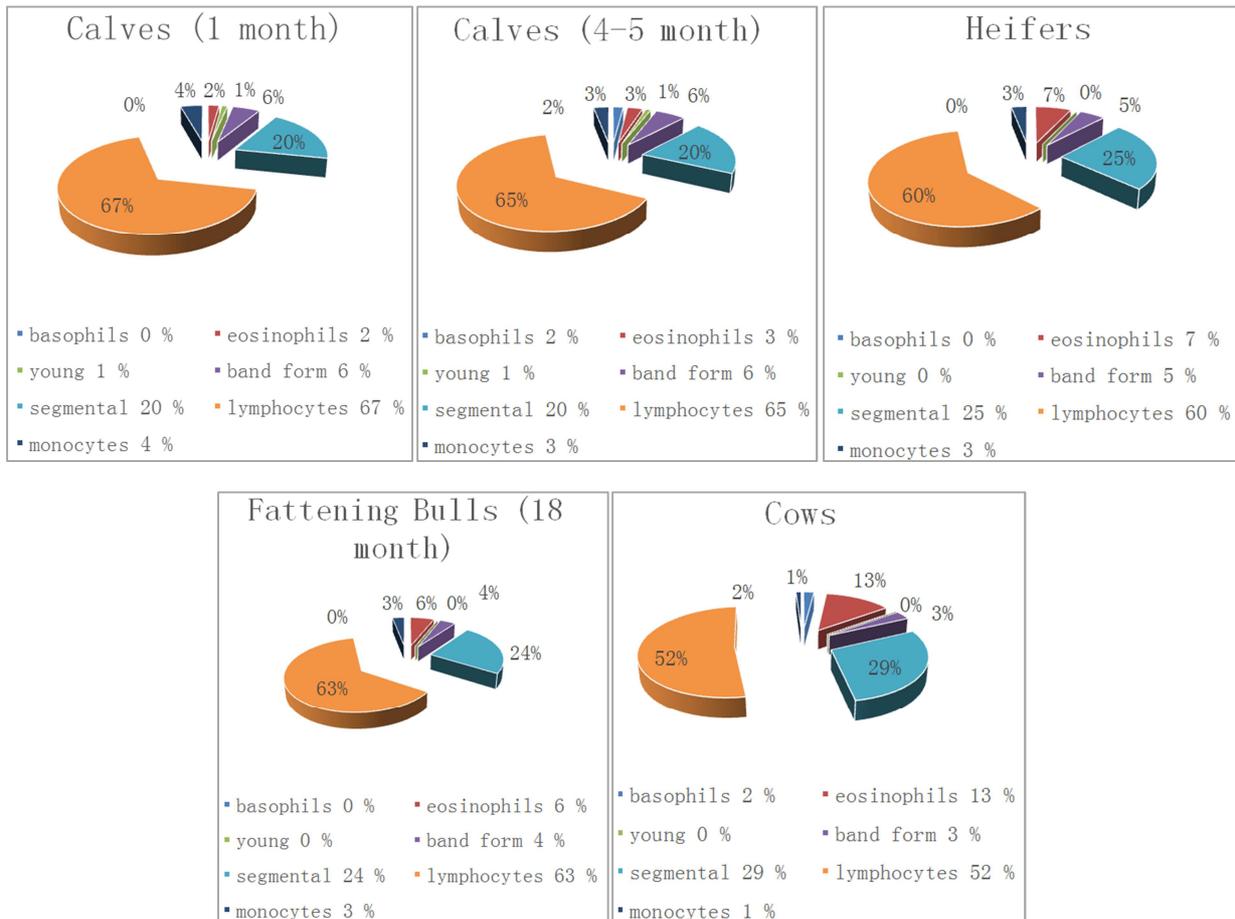


Figure 6. The picture of white blood of Simmental breed animals in postnatal ontogenesis, in conditions of low level of selenium, iodine and cobalt in environment and forages.

Leukocyte formulas of Simmental breed cattle imported from Austria (Figure 6), show that the white blood parameters in all age and sex groups were generally within the physiological norm for this species. Milk yield of Simmental cows in the biochemical conditions of the Lower Volga region is much lower than in Austria, although higher than of the local, once simmentalized crossbreeds of dairy cows.

High yielding Simmental cows in the conditions of Austria and the EU countries give more than 6 thousand liters or more per year, having an intense metabolism and high productivity, are characterized by a fine sensitivity to even minor violations of the conditions of feeding, maintenance and climatic and geochemical factors of the environment causing the stress state, changing the level of lipid peroxidation and the nature of antioxidant system.

Table 3. Biochemical picture of blood serum of Simmental breed ruminants of different ages.

Blood counts	Fluctuations of "normal" physiological parameters	Age of animals				
		calves, 1 month	calves, 4-6 months	bulls, (fattening)	heifers	cows
carotene, mg/%	0.3-1.1	0.04±0.01*	0.06±0.01	0.13±0.02	0.07±0.03	0.06±0.01
total protein, g/%	6.9-8.3	4.0±0.05*	4.1±0.06	4.3±0.46	6.1±0.15	6.6±0.08*
calcium, mg/%	9.4-11.6	7.5±0.03*	8.3±0.05*	8.1±0.16	7.9±1.07*	8.1±0.17*
phosphorus, mg/%	4.6-6.8	3.7±0.02	3.9±0.03	3.7±0.34	3.9±0.05	4.0±0.05
glucose, mol/g	1.9-3.4	1.7±0.04	1.7±0.09	1.5±0.16	1.09±0.02	1.21±0.09
alkaline reserve, volume, % CO ₂	43-62	32.2±2.08*	31.6±2.3*	36.1±2.5*	48.1±1.5	42.2±3.61
common lipids, mg%	321-363	311±13.6	310.8±6.9	322±11	339*±7.7	341±8.8*
cholesterol, mg%	80-155	161±5.8	165±9.9	158±6.2	170±9.8*	179±8.2*

*- P<0.05.

Analyzing biochemical parameters of blood of Simmental breed cattle (Table 3), a significant increase in total protein with age (p<0.05) should be noted. The alkaline reserve of Simmental cows is also slightly higher than that of calves (p<0.05). It should be noted that all the studied physiological parameters of blood in Simmentals were at the lower limit of physiological norm (carotene, total protein, glucose, phosphorus, acid capacity) or were even lower than it (Ca, glucose, phosphorus), which indicates that cows imported from Austria have not adapted fully yet to the new climatic and geochemical conditions of the environment (low levels of iodine, cobalt and selenium in the environment and animal feed, feed quality, high temperatures in the summer, water chemistry, etc.). The level of calcium in the blood of acclimatized Simmentals is definitely lower than the average physiological norm during the whole ontogenesis.

The biochemical composition of the blood of cattle undergoes certain changes with age. The total lipids in the blood of cows and heifers are greater than in calves aged one to six months. The amount of cholesterol in calves aged from one to six months, in bulls on fattening less than in heifers before mating and cows.

It is well known that a significant part of the organic iodine in the blood is in the form of T₄ (thyroxine), the biosynthesis of which takes place in the thyroid gland in several stages. About 70% of thyroxine is associated with thyroxine - binding globulin (TBG), 20% with thyroxine -

binding prealbumin (TBPA) and 10% with albumin. The half-life of thyroxine is about 7-8 days. It is destined more durable than triiodothyronine, thyroxine binding with certain proteins. Only 0.02-0.04% of this hormone remains unaffected with proteins. It is considered that this free fraction of T₄ (thyroxine) stimulates metabolism. Therefore, the level of iodine-containing hormone in the blood is a common indicator of thyroid function [7], which was studied in the work.

Studies of the thyroxine hormone level in blood serum of Simmental calves, bulls, heifers and cows in Astrakhan region (Table 4) showed that in the state of hypothyroidism there is a very significant number of animals (Figure 7). In 35.8% of cases, monthly calves had the amount of hormone from 28 to 46 nm/l, in bulls on fattening in 32.6% of cases thyroxine values ranged from 23 to 47 nm/l, and 49.4% of heifers had 22-46 nm/l thyroxine. Among 96 cows studied by us, in 76.5% of the cases, thyroxine indices in the studied animals ranged from 12 to 43 nm/l, at a norm of 50-150 nm/l, which is the basis for the diagnosis of thyroid hypofunction (iodine hypoelementosis in ruminants) and indicates the need to restore (correction) iodine deficiency in the feed diets of Simmental calves, bulls, cows and heifers in the biogeochemical conditions of the Lower Volga region, where deficiency of iodine, selenium and cobalt in soil, plants, feed and water is revealed [1].

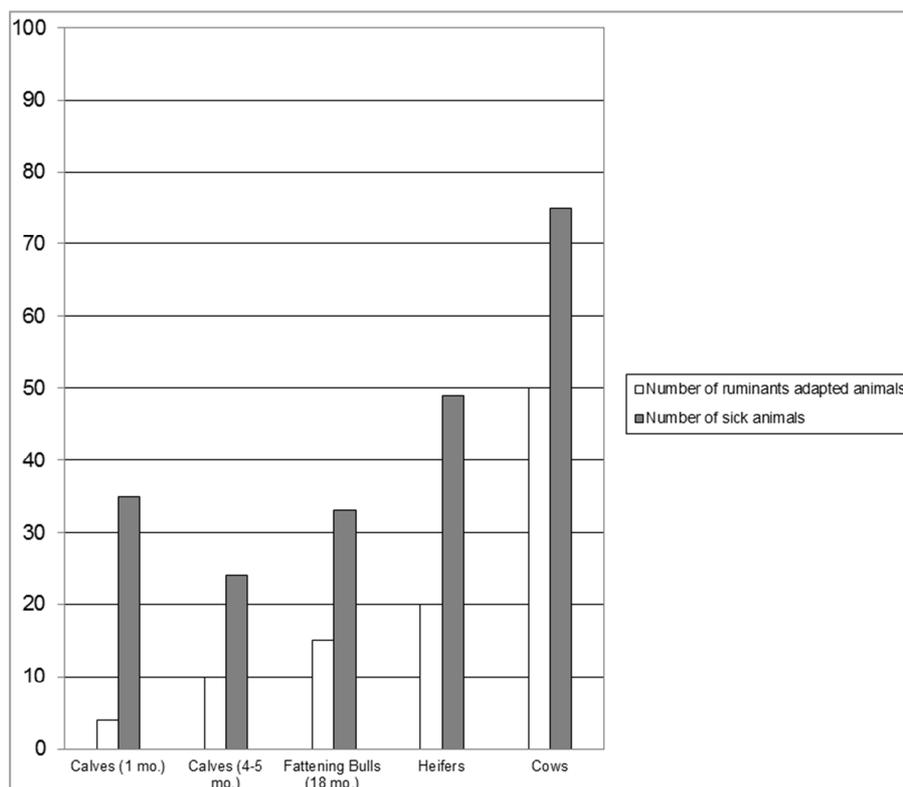


Figure 7. Number of ruminants adapted and sick with hypothyroidism in Astrakhan region.

Table 4. Indicators of peroxidation in antioxidant and endocrine systems of Simmental cows.

Biochemical parameters of blood animals	Time parametes				
	cows before calving	cows, 6 th day after calving	calves, 90 days	calves, 180 days	cows, 225 th day of lactation
adrenocorticotrop hormone (ACTH), PG/ml	90±2.3	90±2.5	32±1.6	36±1.4	37±1.6
thyroxine, nm/l	96±3.1	72±1.9	41±1.2	41±1.3	44±1.8
cortisol, nmol /l	33.28±1.24	33.11±1.16	32.92±1.45	31.58±2.17	31.48±1.18
diene conjugates(DC), m.d. area/ml	33.22±2.15	33.51±1.47	31.04±1.56	30.69±2.23	30.97±2.07*
malonic dialdehyde (DC), µm/l	162±2.6	161±3.7	145±2.9	142±2.3	146±2.5
Schiff base (SHB), m.d. area/ml	159±2.9	160±4.3	143±2.1	149±4.4	140±3.8
peroxide resistance of erythrocytes, %	3.71±0.02	3.82±0.06	2.51±0.05	2.22±0.04	3.54±0.04
vitamin E, mkm/l	2.97±0.09	2.63±0.11	2.43±0.08	2.21±0.07	3.43±0.05
vitamin A, mkm/l	2.32±0.04	2.36±0.09	2.01±0.07	1.88±0.03	2.29±0.06
vitamin C, mkm/l	2.35±0.01	2.34±0.04	1.77±0.08	1.59±0.03	2.51±0.02
catalase, mkm/ml	0.31±0.06	0.32±0.02	0.19±0.01	0.18±0.07	0.21±0.02
superoxide dismutase (SOD), u/min	0.31±0.08	0.33±0.05	0.23±0.07	0.21±0.04	0.36±0.01
glutathione peroxidase (GPO), mMg-SM l/min	3.03±0.02	2.99±0.02	2.35±0.02	2.11±0.06	2.79±0.01
glutathione reduced, mmol/l	2.95±0.04	3.04±0.08	2.28±0.06	1.91±0.03	2.85±0.04
	6.62±1.04	7.73±1.06	8.03±1.04	8.03±0.96	10.06±0.08
	6.31±1.02	7.58±1.02	8.08±1.12	12.02±1.14	10.14±0.56
	0.63±0.33	1.20±0.03	2.51±0.13	9.06±0.13	1.01±0.16
	0.59±0.08	0.88±0.02	2.69±0.07	2.11±0.08	1.09±0.04
	40.93±3.37	41.51±4.25	50±3.28	48±4.09	32±2.12
	41.26±2.19	40.17±3.07	50±2.19	47±3.19	30±1.29
	1.98±0.03	2.04±0.03	2.42±0.03	2.56±0.08	1.56±0.02
	2.01±0.01	0.02±0.05	2.38±0.03	2.72±0.02	1.49±0.05
	161±4.2	172±5.5	196±8.2	182±9.6	158±8.1
	169±5.6	178±8.9	209±7.3	175±9.9	164±5.5
	8.4±0.03	9.0±0.02	9.8±0.01	10.5±0.05	8.3±0.16
	8.1±0.04	8.7±0.04	10.2±0.04	10.9±0.02	8.2±0.08
	0.41±0.07	0.25±0.02	0.38±0.07	0.32±0.03	0.29±0.06
	0.28±0.02	0.29±0.01	0.41±0.01	0.42±0.03	0.29±0.02

* Numerator – parameters of first-calf heifers blood (n=5) and calves (n=5)
Denominator – parameters of cows blood (n=7) and calves (n=8)

4. Discussion

Hypothalamus – pituitary – adrenal cortex work in the body as a single system. The secreted hypothalamic neuron and corticotropin-releasing hormone (CRH) enter the portal system of blood vessels in the pituitary gland and stimulates the secretion of ACTH. The latter induces the synthesis and secretion of cortisol in the adrenal glands, which inhibits secretory activity of the pituitary gland and hypothalamus by the mechanism of negative feedback. The balance of this system can be easily disturbed by environmental factors, especially stress factors, which include climatic influences [3-5, 10], the lack of micronutrients [2, 11, 12]. It should be noted that the level of ACTH and cortisol, which are among the stress hormones, was the highest before calving and 5 days after (Table 3). ACTH, cortisol and thyroxine remained at almost constant levels between 3 and 7 months of pregnancy in first-calf heifers and cows. At comparing ACTH with malonic dialdehyde, a positive correlation ($r=+0.71$) and negative in ACTH-SOD= $R=-0.61$ and ACTH–glutathione peroxidase - $r=-0.67$, ACTH – catalase– $r=-0.66$ pairs were revealed. The relationship of ACTH with glutathione was not detected. A positive connection was established between cortisol and SOD ($r=0.7$). Attention is drawn to the amount of thyroxine (T_4) in the blood serum of Simmental cows and heifers, which ranged from 31.28 to 33.5 nm/l (32.4 ± 1.43 nm/l), which is much lower than the physiological norm (50-150 nm/l).

The effect of stress factors is associated with the intensification of free radical oxidation (FRO), resulting in the depletion of the natural antioxidant system, develops a state of oxidative stress in animals [8, 13-15]. The antioxidant system (AOS) is a multi-component system whose role is to maintain the oxidation and reduction equilibrium and eliminate the products of FRO. Thus, the amount of free radicals formed in the body is controlled. A large number of biochemical reactions in animals occurs with the participation of free radicals, which play an important role in metabolic processes. It is known that the FRO is normal metabolic process at low intensity [13-15]. Activation of FRO processes includes the launch of the mechanism of cascade reactions, which lead to the depletion of its own antioxidant system, i.e. cause the developed states of oxidative stress and metabolic disorders. It was considered that to increase the adaptive reactivity of the organism of adapting Simmentals under the influence of negative environmental factors, including low levels of Se, J and Co in feed and water, it is necessary to apply various means of adaptive action especially for imported animals from other regions of the world. Today special attention is paid to the means of antioxidant action of natural origin, characterized by high bioavailability and environmental cleanliness, which probably include trace elements (Se, J and Co), which are not enough for animals in feed and water in the biogeochemical conditions of the Lower Volga region, including Astrakhan region.

5. Conclusion

The level of peroxide products is one of the most important factors characterizing the homeostasis of all body systems. The intensity of the level of free radical oxidation (FRO) in cell membranes and subcellular structures can be judged by the content in the blood of diene conjugants (DC), malonic dialdehyde (MDA) and the level of Schiff bases (Table3). An indicator of the state of the antioxidant system (AOS) is also the level of peroxide resistance of red blood cells (PRE), rising before calving and immediately after calving, relative to the summer and autumn periods. It is characteristic that the level of primary - DC, secondary - MDA and final - Schiff base – lipid peroxidation products was higher in Simmental cows (a few days before calving) and immediately (5 days) after calving than in summer and autumn. This indicates that the animals are far from being fully adapted to new (Astrakhan) geochemical conditions of life in both the first and second generation and that the process of adaptation is complicated by the sharply continental climate, feed quality and, of course, low levels of essential trace elements - Se, J and Co in terrestrial grazing ecosystems (soil, plants, water, animal feed) and therefore biogeochemical conditions of the Lower Volga region to improve the reactions of adaptation of imported Austrian Simmental cows should apply the missing trace elements - adaptogens. These LPO and AOS of heifers and their mothers differ little, which indicates the difficulties of the adaptation period in these ruminants. Attention is also drawn to the tendency of increasing the activity of antioxidant enzymes in the summer-autumn period, when the level of DC, MDA, SHO, PRE decreases. All of the above in conjunction with the change in the quality of feed and climatic conditions of Astrakhan region about the environmental conditions of Austria explains the lower productivity of Simmental cows with 6 000-7 500 kg in Austria until 4 000 - 4 500 kg of milk per year in the Lower Volga region and incomplete use of the genetic potential of Simmental cows imported from the Alpine meadows of Austria and poorly adapted to Astrakhan habitat.

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