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Functional Activity Of Anticoagulant System In Calves During Early Ontogeny

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ABSTRACT

The ontogenetic dynamics of the haemostatic mechanisms of blood plasma during the period of growth and development of the animal is of great physiological importance for providing them with homeostasis. The necessary level of functional activity of the anticoagulant system largely ensures adaptation to the external environment of all body systems, controlling the liquid-bone properties of blood, maintaining the level of its fluidity through the vessels, promoting optimal growth and maturation of organs and systems in the calf. At the same time, the dynamics of the activity of the anti-typhoid system in healthy calves at various forms of nutrition in early ontogenesis has not been studied enough. The current dynamics of anticoagulation activity ensures, during early ontogeny, the necessary level of fluid properties of blood and the optimal degree of perfusion of internal organs, which largely supports the metabolism in calf tissues, contributing to its further growth and development and is an indispensable element of the final functional maturation of the organism in conditions transition from one feed to another.

Keywords: phase of milk supply, phase of milk nutrition, phase of milk and vegetable nutrition, phase of plant nutrition, anticoagulant system of blood.

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INTRODUCTION

Preservation of the stability of the society and its continuous progressive development is possible if there is enough food [1,2,3]. A serious source in many countries of the world is cattle breeding, which gives milk and a large volume of meat [4,5].

Further intensification of cattle breeding is possible during the active use of new physiological knowledge about young cattle [6,7]. Particularly important in this regard is the anticoagulation system, which ensures the preservation of blood in the liquid state [8]. In this connection, the ontogenetic dynamics of the haemostatic mechanisms of blood plasma during the growth and development of the animal has great physiological significance for providing homeostasis for them [9]. The necessary level of functional activity of the anticoagulant system largely ensures the adaptation to the external environment of all body systems, controlling the liquid properties of the blood, maintaining the level of its fluidity along the vessels, promoting optimal growth and maturation of organs and systems in the calf [10]. At the same time, the dynamics of the activity of the anticoagulant system in healthy calves with various forms of nutrition in early ontogeny has not been studied sufficiently [11].

In this regard, the goal of the study was formulated: to establish the ontogenetic dynamics of the activity of the anticoagulant system of blood plasma in healthy calves during early ontogeny.

MATERIALS AND METHODS

Research was conducted in strict accordance with ethical principles established by the European Convent on protection of the vertebrata used for experimental and other scientific purposes (adopted in Strasbourg March 18, 1986, and confirmed in Strasbourg June 15, 2006) and approved by the local ethic committee of Russian State Social University (Record №12 dated December 3, 2015).

The study included 29 physiologically mature, healthy newborn calves for 1-2 days of life, 32 healthy calf dairy for 11 days of life, 36 healthy calves of milk and vegetable nutrition, taken for 31 days of life, 39 healthy calves of plant nutrition, taken under observation for 91 days of life. All calves were black-motley and Simmental breeds with normal indicators of laboratory and instrumental studies and subsequently did not have any deviations in health status. The complex of examinations consisted of the determination of the activity of lipid peroxidation (LPO) in the content of acyl hydroperoxides and thiobarbituric acid-active products by the Agat-Med company (Russia) with an evaluation of the antioxidant activity of the liquid part of the blood. Each calf under observation was evaluated for the activity of the anticoagulant system of blood plasma by determining the activity of antithrombin III and protein C in plasma.

The calves included in the study were inspected and examined during the phase of colostrum nutrition on day 1-2, 3-4 days, 5-6 days, 7-8 days and 9-10 days. The observed calves of dairy nutrition were examined on 11, 15, 20, 25 and 30 days of life. The indicators taken into account in healthy calves of milk and vegetable nutrition were determined: at 31, 45, 60, 75 and 90 days of life. During the phase of plant feeding calves were examined 4 times: 91 days, 6 months, 9 months and 12 months of life.

Statistical processing of the results was carried out using Student's t-test.

RESULTS OF THE STUDY

During the neonatal phase in healthy calves, the activity of peroxide oxidation of plasma lipids was found to be constant (Table 1). At the same time, the concentration of thiobarbituric acid-active products and the level of acyl hydroperoxides in their blood plasma did not experience significant dynamics during the whole phase of the neonatal period. The stability of lipid peroxidation was ensured by the constancy of the calves during the milk supply phase of the level of antioxidant protection of the body - the antioxidant potential of the plasma in them on the average was 33.7±0.14% for the newborn. During the phase of milk nutrition in healthy calves, stability of the level of antioxidant activity of plasma (on average 32.6±0.21%) and activity of blood lipid peroxidation was also noted. The level of primary products of lipid peroxidation - acyl hydroperoxides averaged 1.48±0.02 D_{233}/1ml with a low content of secondary products of free radical lipid oxidation - thiobarbituric acid-active compounds (average 3.29±0.02 μmol/l) authentically does not differ

from research to research during the whole phase of dairy nutrition. In the phase of milk and vegetable nutrition in healthy calves, the attenuation of the antioxidant activity level of the plasma to 27.4±0.15% was registered for 45 days of life, with subsequent increase to 33.9±0.24% by 90 days of life. This caused the revealed dynamics of the level of acyl hydroperoxides: by 45 days, its peak (1.80±0.14 D_{233}/1 ml) was noted with a subsequent decrease (1.41±0.11 D_{233}/1 ml) to values lower than at the beginning of the phase. This was accompanied by a similar dynamics of the content of tiobbituric acid-active compounds (at 45 day 3.77±0.16 µmol/l, at day 3.45±0.19 µmol/l at day 90), returning to the values typical for thiobarbituric acid products at the beginning of the phase of milk and vegetable nutrition. In healthy calves of plant nutrition, there was a gradual increase in the level of antioxidant activity of the plasma to 34.7±0.07% by 6 months. with the subsequent its additional increase to 36,5±0,10% to 12 months life. This led to a decrease in the level of acyl hydroperoxides by 6 months to 1,33±0,07 D_{233}/1 ml to 12 months. life up to 1,21±0,14 D_{233}/1 ml and thiobarbituric acid-active compounds by 6 months 3,36±0,12 µmol/l, by 12 months 3,18±0,12 µmol/l.

In the blood of healthy newborn calves, there is an easy tendency to increase the level of antithrombin III, an average of 99.3±0.16%. At the same time, the level of protein C significantly increased in calves during all the first 10 days of life from 50.1±0.24% to 75.2±0.16% (Table 1). An insignificant but significant increase in the level of antithrombin III, an average of 105.2±0.13%, was found in dairy animals. Simultaneously, there was a significant increase during the milk feeding phase of protein C level in calves between 11 and 30 days of life from 76.0±0.10% to 83.5±0.08%.

The healthy calves of milk and vegetal nutrition tested had a significant increase in blood levels of antithrombin III to 45 days of life to 122.7±0.20%. At the same time, the activity peak of the protein C level was 98.0±0.08%. In the subsequent to 60 days of life, the activity of anticoagulants decreased, testing in the subsequent small significant increase. So, in the examined healthy calves of plant nutrition, a significant increase in the blood level of antithrombin III to 6 months was found life to 123.1±0.11%. At the same time, an increase in the activity of the protein C level to 97.3±0.14% was observed at this age. Subsequently, by the time of 12 months of life, the activity of the anticoagulants was additionally reliably increased.

Thus, during the change in dietary habits in early ontogenesis calves have a regular dynamics associated with a gradual and reliable increase in plasma levels of antithrombin III and protein C activity with a jump in their activity by 45 days, followed by recovery at a level close to the values at the beginning of the milk-vegetative nutrition and further increase to 12 months of life, which is undoubtedly an important element of animal adaptation to changing food conditions, contributing to the transition of their hemostasis to a level requiring for the further growth and development of the body.

DISCUSSION

The study found that during the neonatal phase in healthy calves, the activity of the antioxidant potential of the plasma and the levels of the primary products of lipid peroxidation - acyl hydroperoxide and secondary - thiobarbituric acid-active compounds are stable, which is probably necessary for this type of productive animals for the development of antistress mechanisms of its homeostasis at this stage of development [12,13]. A low level of plasma lipid peroxidation causes a weak alteration of endotheliocytes and components of the liquid part of the blood, contributing to weak stimulation of plasma hemostasis [14,15,16].

The anticoagulant ability of plasma in healthy newborn calves largely determines the activity of antithrombin III and protein C, ensuring the balance of anticoagulants and procoagulants [17,18]. This can be confirmed by the absence of signs of thromboses and hemorrhages in a healthy newborn, largely due to the rather high activity of anticoagulation, which allows the calf organism to respond adequately to unfavorable environmental factors, which usually have a procoagulant effect on hemostasis [19,20].

In calves in the phase of dairy nutrition, there is a lack of reliable fluctuations in the level of lipid peroxidation and antioxidant protection of the plasma with a certain dynamics of activity of anticoagulation, which undoubtedly allows the calf organism to later adapt to the conditions of extrauterine existence, providing a normal rheological state of the blood, and thus adequate the inflow of nutrients and oxygen to the developing tissues of the animal's body [21,22]. This is an important element of protecting calves against possible adverse environmental factors affecting their body during the phase of milk nutrition [23].

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Table 1. Activity of indicators in calves in early ontogeny

Registered parameters	Newborn phase, n=29, M±m		Milk phase, n=32, M±m		Milk and vegetable nutrition phase, n=36, M±m					Phase of plant nutrition, n=39, M±m			
	1-2 day of life	9-10 day of life	11 day of life	30 day of life	31 day of life	45 day of life	60 day of life	75 day of life	90 day of life	91 day of life	6 months of life	9 months of life	12 months of life
Acid hydroperoxide of plasma, $Д_{233}$ /1 ml	1.49±0.10	1.44±0.12	1.46±0.07	1.53±0.20	1.54±0.08	1.80±0.14 p<0.01	1.66±0.12 p<0.01	1.42±0.15 p<0.01	1.41±0.11	1.40±0.09	1.33±0.07 p<0.05	1.28±0.17 p<0.05	1.21±0.14 p<0.05
Thiobarbituric acid products, µmol/l	3.49±0.11	3.47±0.11	3.51±0.14	3.55±0.16	3.59±0.22	3.77±0.16 p<0.01	3.67±0.14 p<0.01	3.51±0.23 p<0.01	3.45±0.19	3.43±0.25	3.36±0.12 p<0.05	3.27±0.16 p<0.05	3.18±0.12 p<0.05
Antioxidant plasma potential,%	34.2±0.16	33.5±0.09	32.8±0.23	32.8±0.15	29.3±0.17	27.4±0.15 p<0.05	30.6±0.14 p<0.01	32.8±0.12 p<0.01	33.9±0.24	33.9±0.09	34.7±0.07 p<0.05	35.4±0.08 p<0.05	36.5±0.10 p<0.05
Antithrombin III activity in plasma,%	96.2±0.11	102.1±0.19	101.7±0.07	108.2±0.16 p<0.05	109.1±0.04	122.7±0.20 p<0.01	114.6±0.06 p<0.01	116.8±0.08 p<0.05	119.9±0.10 p<0.05	120.1±0.07	123.1±0.11 p<0.01	126.4±0.05 p<0.01	129.0±0.07 p<0.01
Protein C, %	50.1±0.24	75.2±0.16 p<0.01	76.0±0.10	83.5±0.08 p<0.05	84.0±0.12	98.0±0.10 p<0.01	87.3±0.16 p<0.01	89.5±0.04 p<0.05	93.6±0.03 p<0.05	94.0±0.15	97.3±0.14 p<0.01	99.7±0.08 p<0.01	104.6±0.06 p<0.01

Legend: p - reliability of the dynamics of indicators from research to research.

The significant increase in the level of lipid peroxidation with the weakening of antioxidant protection of the plasma at the beginning of the phase of milk and vegetable nutrition, with a marked increase in the activity of anticoagulation, maintains the optimal level of adaptation of the calf's organism to changing feeding conditions, preserving the normal rheological state of the blood, and thereby adequate inflow of nutrients and oxygen to the growing tissues of the animal's body [24]. Undoubtedly, this is an important element of the reaction of the calves' organism at the beginning of feeding with plant foods, which can be considered as a strong stimulus of the external environment [25], affecting their organism at the beginning of the phase of milk and vegetable nutrition and to which the animal adapts rapidly [26]. The dynamics of the anticoagulation system controlling the aggregate state of blood is largely ensured by the level of lipid peroxidation, ensuring its adequate readiness to respond to environmental factors [27,28]. Thus, during the phase of milk and vegetable nutrition, antithrombin III and protein C significantly increase with a sharp jump to 45 days and subsequent smooth changes [29,30]. Obviously, this is a physiological response to the adaptation of the organism and during the final transition to plant nutrition for up to a year of life and successfully provides the necessary conditions for microcirculation in tissues [31-33].

CONCLUSION

The dynamics of the activity of anticoagulation during the early ontogeny ensures the necessary level of liquid blood properties and the optimal degree of perfusion of the internal organs, which largely supports the metabolism in calf tissues, contributing to its further growth and development and is an indispensable element of the final functional maturation of the organism under the transition from one consumed food to another.

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