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Functional Properties Of Coagulation Hemostasis In Calves During The Phase Of Dairy-Vegetative Nutrition.

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ABSTRACT

The interrelation of ontogenetic dynamics of the activity of coagulation, anticoagulant and fibrinolytic blood plasma systems in the phase of dairy-vegetative nutrition in calves is a serious physiological element of maintaining homeostasis in the postnatal period. Functional activity of all elements of coagulation hemostasis, providing adaptation to the external environment of all body systems through the maintenance of fluid properties of blood in often unfavorable environmental conditions, contributes to the optimal deployment of an individual calf development program. Moreover, many aspects of age-related changes in activity and interaction of coagulating, anticoagulant and fibrinolytic systems in healthy calves in the phase of milk and plant nutrition have not been sufficiently studied. In healthy calves of milk and vegetable nutrition there is a regular dynamics of the functional state of the activity of elements of coagulation hemostasis, which ensures the optimal rheology of blood necessary for the growth and development of the organism. The increase in the activity of mutually balanced mechanisms of blood coagulation, anticoagulation and fibrinolysis helps the animal to adapt to the phase of dairy-plant nutrition, providing a transition to nutrition with plant foods.

Keywords: calves, coagulation, hemostasis, phase of dairy-vegetative nutrition, physiology.

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INTRODUCTION

Providing the society with a sufficient number of quality products is an important problem of maintaining social stability and development of various spheres of human activity [1,2,3]. In solving this problem, an important place in many countries of the world is assigned to animal husbandry [4]. Modern science sees a serious reserve for the intensification of animal husbandry in the active practical application of new physiological knowledge about large cattle [5]. In this connection, it is necessary to further actively obtain new knowledge about the physiology of calves at the end of their early ontogenesis, when the foundations of their productive properties are actively formed [6]. Great importance is given to the physiology of blood and mechanisms that ensure its permanence [7].

The interrelation of ontogenetic dynamics of the activity of coagulation, anticoagulant and fibrinolytic blood plasma systems in the phase of dairy-vegetative nutrition in calves is a serious physiological element of maintaining homeostasis in the postnatal period. Functional activity of all elements of coagulation hemostasis, providing adaptation to the external environment of all body systems through the maintenance of fluid properties of blood in often unfavorable environmental conditions, contributes to the optimal deployment of an individual calf development program. Moreover, many aspects of age-related changes in activity and interaction of coagulating, anticoagulant and fibrinolytic systems in healthy calves in the phase of milk and plant nutrition have not been sufficiently studied.

In this connection, the goal of the study was formulated: to establish the dynamics of the physiological state of coagulation, anticoagulant and fibrinolytic systems of blood plasma in healthy calves in the phase of milk and vegetable nutrition.

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 36 healthy calves of milk and vegetable nutrition at the age of 31 days. The complex of examinations consisted of determining the activity of peroxide oxidation of plasma lipids by the content of acyl hydroperoxides, thiobarbituric acid-active products by the Agat-Med company (Russia) and the antioxidant activity of the liquid part of the blood. Each level of the monitored calf was evaluated for the level of coagulation factors (I, II, V, VII, VIII, IX, X, XI, XII), duration of activated partial thromboplastin time, prothrombin and thrombin time.

The activity of the anticoagulant system of blood plasma was assessed by determining the activity of antithrombin III and protein C in plasma.

To determine the activity of fibrinolytic ability of blood plasma in neonatal calves, a method for determining the time of spontaneous euglobulin lysis, the level of plasminogen, α_2 antiplasmin, and the content of fibrin degradation products by the phenanthroline method was used.

All calves were examined during the phase of milk and vegetable nutrition five times: at 31, 45, 60, 75 and 90 days of life.

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

RESULTS OF THE STUDY

At the beginning of the phase of milk and vegetable nutrition (45 days) in healthy calves there was a significant decrease in the level of antioxidant activity of the plasma (27.4±0.15%), which led to increased activity of lipid peroxidation. Thus, the level of primary products of lipid peroxidation, acyl hydroperoxides, was 1.80±0.14 D_{233}/1ml for 45 days, with a sharp increase in the content of secondary products of free radical

lipid oxidation-thiobarbituric acid-active compounds (3.77±0.16 µmol/l) with their subsequent return (60 days) to a level close to those at the beginning of the phase and a small but significant gradual increase in antioxidant activity (up to 33.9±0.24%) at 90 days and a decrease in lipid peroxidation, which was 90 days - acylhydro peroxides 1,41±0,11 D_{233}/1 ml, thiobarbituric acid products 3,45±0,19 µmol/l.

All healthy calves included in the study evaluated the activity of blood coagulation factors throughout the whole phase of the dairy-plant nutrition. In the dynamics of activity of coagulation factors, they found a statistically significant regularity (Table 1).

On the 31st day of life in calves, the low activity of all clotting factors was noted. By 45 days of life, the animals showed a marked increase in the content of factors I, II, VII, IX, X, XI and XII with the same content of V and VIII factors. By 60 days in calves, a decrease in the activity of activated factors to a level close to that at the beginning of the phase was noted, followed by a small but significant increase in their functional readiness until the end of the observation. At the same time, in the calves the levels of factors V and VIII remained unchanged up to 90 days.

Coagulation tests in healthy calves during the phase of milk and vegetable nutrition reflected the patterns of activity dynamics in the elements of the coagulation system associated with changes in the plasma content of individual clotting factors in this phase of early ontogeny (Table 1). Thus, when assessing the age-related dynamics of activated partial thromboplastin time, its acceleration by 45 days of life was ascertained to 34.2±0.18 s, extending to 60 days again to 39.9±0.12 s and slowly accelerating to its end to 38.6±0.16 s. Prothrombin time, slowed down at the beginning of the phase, reached 12.8±0.12 s with 45 days of inhibition to 60 days before the initial values and its subsequent steady contraction to the end of the phase. Thrombin time, reflecting the intensity of the transition of fibrinogen to fibrin, from the 31st to the 90th day of life in calves was accelerated by 2.0%, testing the peak acceleration to 13.0±0.16s by 45 days.

All observed healthy calves included in the study evaluated the activity of anticoagulant and fibrinolytic activity of blood throughout the entire phase of the dairy-plant nutrition. In the dynamics of activity of the components evaluated in calves, a statistically significant pattern was found (Table 1).

Table 1. Dynamics of hemostasis activity in calves of milk and vegetable nutrition

Registered parameters	Milk and vegetable nutrition phase, n=36, M±m				
	31 day of life	45 day of life	60 day of life	75 day of life	90 day of life
Coagulation factor I, g/l	3.0±0.12	4.7±0.25 p<0.01	3.2±0.07 p<0.01	3.3±0.04	3.5±0.16 p<0.05
Coagulation factor II, %	87.5±0.10	98.0±0.19 p<0.01	86.8±0.04 p<0.01	87.5±0.02 p<0.05	88.9±0.03 p<0.05
Coagulation factor V, %	82.9±0.14	83.5±0.08	83.4±0.07	82.9±0.10	84.0±0.06
Coagulation factor VII, %	72.8±0.06	85.1±0.08 p<0.01	73.4±0.06 p<0.01	74.2±0.05 p<0.05	76.2±0.05
Coagulation factor VIII, %	86.1±0.12	86.8±0.15	87.0±0.19	86.6±0.20	86.9±0.14
Coagulation factor IX, %	86.7±0.13	94.7±0.12 p<0.01	88.2±0.02 p<0.01	88.6±0.04	88.0±0.12
Coagulation factor X, %	63.3±0.20	69.9±0.19 p<0.01	62.4±0.25 p<0.01	62.8±0.14	63.4±0.12
Coagulation factor XI, %	94.8±0.18	99.7±0.16 p<0.01	93.8±0.18 p<0.01	94.5±0.15	94.8±0.17
Coagulation factor XII, %	92.3±0.10	106.2±0.22 p<0.01	94.0±0.07 p<0.01	95.6±0.09 p<0.05	96.6±0.13 p<0.05
Activated partial thromboplastin time, s	39.7±0.18	34.2±0.18 p<0.01	39.9±0.12 p<0.01	39.0±0.04 p<0.05	38.6±0.16

Prothrombin time, s	16.2±0.18	12.8±0.12 p<0.01	16.5±0.05 p<0.01	16.2±0.06 p<0.01	16.0±0.03
Thrombin time, s	15.0±0.07	13.0±0.16 p<0.01	15.2±0.16 p<0.01	14.8±0.06 p<0.05	14.7 ±0.03
The activity of antithrombin III in plasma, %	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
Protein C, %	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
Time of spontaneous euglobulin lysis, minutes	170.0±0.26	152.3±0.10 p<0.01	167.7±0.14 p<0.01	165.0±0.13 p<0.05	162.1±0.09 p<0.05
Plasminogen, %	128.9±0.02	138.8±0.07 p<0.01	130.2±0.09 p<0.01	132.6±0.08 p<0.05	134.5±0.08 p<0.05
α_2 antiplasmin, %	96.1±0.15	80.4±0.17 p<0.01	93.6±0.05 p<0.01	90.4±0.08 p<0.05	89.0±0.03 p<0.05
Fibrin degradation products, µg / ml	42.9±0.16	55.8±0.25 p<0.01	44.8±0.29 p<0.01	43.1±0.18	44.0±0.12

Legend: p - reliability of ontogenetic dynamics of the indicators being evaluated.

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, there was a peak activity during the milk-and-vegetable nutrition phase of protein C level of 98.0±0.08%. In the subsequent to 60 days of life, the activity of anticoagulants decreased, testing in the subsequent small significant increase.

During the phase of milk and vegetable nutrition in healthy calves, a similar dynamics of the level of plasminogen was observed with a marked decrease in the inhibitor of its active form - α_2 antiplasmin by 5.1% to 45 days of life, followed by their reduction and a smooth dynamics of their activity, which provided a sharp acceleration in 45 days of life with a subsequent return to values close to the baseline and a peak at 45 days, and in the subsequent consistency of the level of degradation products of fibrin during the phase of milk and vegetable nutrition, which indicated an optimal first level of adaptation to the environment by maintaining the fibrinolytic activity at the required level.

Thus, during the entire phase of milk and vegetable nutrition in calves there is a significant increase in the clotting system with a simultaneous increase in the plasma level of antithrombin III plasminogen, protein C activity and a decrease in α_2 antiplasmin with a jump in their activity by 45 days, followed by recovery at a level close to the values at the beginning of the phase, which is undoubtedly an important element in the adaptation of animals to new nutritional conditions, contributing to the transition of hemostasis to the level required for further growth and development organism and preparing for a full transition to vegetable nutrition.

DISCUSSION

A healthy increase in lipid peroxidation and a decrease in antioxidant protection of the plaque by 45 days of life with a certain dynamics of plasma hemostasis activity is registered in healthy calves of milk and vegetable nutrition, which is undoubtedly a consequence of the adaptation process of the calf organism to the beginning of the plant feed intake, the normal rheological state of the blood, and thus, an adequate influx of nutrients and oxygen to the developing tissues of the animal's body [8,9]. This is an important element of protecting calves against possible adverse environmental factors affecting their body during the phase of milk and vegetable nutrition. The dynamics of the clotting system that controls the aggregate state of blood is largely provided by fluctuations in the activity of lipid peroxidation at the optimal level with the growing influence of environmental factors [10, 11]. The gradual acceleration of the prothrombin clotting time with its peak leaps to 45 days and the subsequent decrease to 60 days reflects the enhancement of mechanisms of activation of plasma hemostasis along the external pathway and is largely due to the increase in this phase in

calves of the intensity of formation and activity triggering the clotting process of thromboplastin [12,13]. Summation of these phenomena provides the level of liquid blood properties necessary for this stage of ontogeny and the optimal degree of perfusion of internal organs, which largely maintains the necessary level of metabolism in calf tissues, contributing to its growth and development [14,15].

During the phase of dairy-vegetative nutrition, the content of V, VIII factors in blood is unchanged, with the activity of the remaining coagulation factors increasing, including. peak to 45 days. Because of this, activated partial thromboplastin time, reflecting the activity of the internal coagulation pathway, prothrombin time, revealing the activity of its external pathway and its terminal stage, estimated by thrombin time, are accelerated [16,17]. It is obvious that the established dynamics of blood clotting activity is an indispensable element of the organism's transition to a new diet - the beginning of consumption of plant foods is in many ways a stress for the organism [18, 19].

During the phase of milk and vegetable nutrition, the activity of inhibitors of coagulation and the level of fibrinolytic agents significantly increase: antithrombin III, protein C and plasminogen are increased and the activity of the fibrinolysis inhibitor-α2-antiplasmin decreases with a sharp jump to 45 days and subsequent smooth change. Obviously, this is a physiological response of the adaptation of the organism in the transition to plant nutrition with an increase in the activity of anticoagulation and fibrinolysis [20,21]. In view of the fact that a slight increase in the total inhibitor of the contact activation of plasma proteases of plasminogen by the end of the phase is accompanied by the maintenance of a stable level in the blood of fibrin degradation products, one can think of a stable adaptation during these periods of functioning of the mechanisms of hemostasis adaptation in these conditions without signs of a hypocoagulant orientation of the hemostasis, microcirculation during hemodynamic adaptation at the end of feeding calf with milk [22,23].

The combination of the dynamics of coagulation, anticoagulation and fibrinolysis provides the level of liquid blood properties necessary for this stage of ontogeny and the optimal degree of perfusion of internal organs, which largely maintains the necessary level of metabolism in calf tissues, contributing to its further growth and development [24,25]. Undoubtedly, the revealed dynamics of the activity of the coagulation system, anticoagulation and fibrinolysis of blood is an indispensable element of the final functional maturation of the organism in conditions of preparation for consumption of only plant foods [26,27,28].

Thus, in calves of dairy-vegetative nutrition there is a functional balance of the clotting system and its limiting systems, providing an adequate level of activity of the entire plasma hemostasis, which is probably an important element of the general adaptation process of the organism in early ontogenesis [29-33].

CONCLUSION

In healthy calves of milk and vegetable nutrition there is a regular dynamics of the functional state of the activity of elements of coagulation hemostasis, which ensures the optimal rheology of blood necessary for the growth and development of the organism. The increase in the activity of mutually balanced mechanisms of blood coagulation, anticoagulation and fibrinolysis helps the animal to adapt to the phase of dairy-plant nutrition, providing a transition to nutrition with plant foods.

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