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Physiological Features Of Vascular Hemostasis In Calves Of Dairy-Vegetative Food.

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ABSTRACT

The processes of synthesis of hemostatically significant substances that flow in the vascular wall exercise control over the state of hemostasis as a whole. The level of their synthesis supports the necessary severity of the liquid properties of the blood and optimal microcirculation in the tissues of the growing animal. The hemostatic capabilities of the vascular wall during the phase of milk and vegetable nutrition are of great adaptive importance, since they play an important role in adapting the calf to switching to feeding plant foods, laying the foundation of the productive qualities of the animal. In the course of the survey, 36 healthy calves of milk and vegetable nutrition of black-motley and Simmental breeds showed a short-term increase in their blood content of acyl hydroperoxides and thiobarbituric acid - active compounds by 45 days of life, accompanied by an increase in endotheliocythemia and an increase in the index of antiaggregatory activity of the vascular wall with all tested inducers. In the vascular wall of calves of milk and vegetable nutrition, by 45 days, a peak increase in the production of antithrombin III and tissue plasminogen activators is observed, which ensure the necessary level of anticoagulants and fibrinolytics of vascular origin in their blood.

Keywords: calves, milk and vegetable nutrition phase, hemostasis, vascular wall, lipid peroxidation.

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INTRODUCTION

Progressive development of the society is now inextricably linked with the further increase in the volume of food production [1,2,3]. In many countries, the reserve of this process is the intensification of animal husbandry through the active use of physiological information about vital body systems [4,5]. A very important system of application in practice of knowledge, which can accelerate the growth and development of calves, is hemostasis [6,7] and features its vascular component [8,9].

The enormous physiological role of blood vessels is currently not in doubt [10]. Pervading all the organs and tissues of the calf, the blood vessels largely regulate the blood flow in them, largely determining the growth and development processes in the body [11,12]. The processes of synthesis of hemostatically significant substances passing through the vascular wall largely control the state of hemostasis as a whole [13,14], supporting the liquid properties of blood and optimal microcirculation in the tissues of the growing animal [15,16]. Undoubtedly, the hemostatic capabilities of the vascular wall in the phase of dairy-vegetative nutrition are of great adaptational importance. they play an important role in adaptation of the calf to the transition to feeding on plant foods [17,18], laying the foundation of the productive qualities of the animal [19,20]. At the same time, the degree of control of the vascular wall over the processes of platelet aggregation and hemocoagulation [21] in calves of milk and vegetable nutrition has been elucidated still not enough [22,23]. In calves of 31-90 days of life, its antiaggregational, anticoagulant and fibrinolytic abilities are not defined. Taking into account these gaps in the scientific knowledge system, the present study was designed and conducted, the purpose of which is to establish the hemostatically significant activity of the vascular wall in healthy calves in the phase of dairy-plant 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 was performed on 36 healthy calves of dairy-vegetative nutrition of black-motley and Simmental breeds. They were inspected and examined 5 times: 31 days, 45 days, 60 days, 75 days and 90 days of life.

In the calves included in the study, the activity of peroxide oxidation of plasma lipids was determined, taking into account the level of acyl hydroperoxides and thiobarbituric acid-active products by the Agat-Med kit (Russia) with an estimate of the antioxidant activity of the plasma. In the blood of calves, the level of endotheliocythemia was determined.

The state of the antiaggregation ability of the vessel walls was determined in a sample with temporal ischemia of the vascular wall when evaluating platelet aggregation on glass with ADP (0.5×10^{-4} M), collagen (1:2 dilution of the base suspension), thrombin (0.125 U/ml) ristomycin (0.8 mg/ml) and epinephrine (5.0×10^{-6} M), as well as their combinations - ADP + epinephrine, ADP + collagen, collagen + epinephrine, ADP + thrombin, ADP + collagen + epinephrine, ADP + thrombin + epinephrine, ADP + collagen + thrombin + epinephrine at the same concentrations with a standardized platelet count in (200×10^9 platelets) before and after temporary venous occlusion with calculation of the index of antiaggregatory activity of the vascular wall by dividing the duration of platelet aggregation against the background of temporary venous occlusion at the time of platelet aggregation without it.

The severity of the anticoagulant abilities of the vessels in calves was estimated from the value of the anticoagulant activity index of the vessel wall, which was calculated by dividing the activity of antithrombin III in plasma after temporary venous occlusion to its activity upstream of it.

The state of control of the vessel wall over the fibrinolytic activity of the blood was recorded by calculating the index of fibrinolytic activity of the vascular wall in dividing the euglobulin lysis time before temporal venous occlusion at the time of lysis after it.

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The results obtained in the study are processed by Student's test (td).

RESULTS OF THE STUDY

In the liquid part of the blood of the observed calves during the phase of milk and plant nutrition, a peak increase in the processes of lipid peroxidation by 45 days with an increase in the number of acyl hydroperoxides and thiobarbituric acid-active compounds to 1.80 ± 0.14 D_{233}/1 ml and 3.77±0.16 µmol/l with a gradual reduction to 90 days of life to 1.41 ± 0.11 D_{233}/1 ml and 3.45±0.19 µmol/l, respectively. The registered dynamics of the intensity of the peroxidation process was possible as a result of a decrease in these terms (27.4±0.15%) in the antioxidant potential of the plasma with subsequent increase to 33.9±0.24% by the end of this phase of individual development.

Table. Gemostatic ability of vessels in calves of dairy-vegetative nutrition

Indicators of vascular hemostasis	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
index antiaggregatory activity of the vascular wall with ADP	1.79±0.12	1.85±0.24 p<0.01	1.82±0.09 p<0.05	1.78±0.02 p<0.05	1.78±0.07
index antiaggregatory activity of the vascular wall with collagen	1.63±0.05	1.71±0.24 p<0.01	1.68±0.08 p<0.05	1.65±0.09 p<0.05	1.64±0.03
index antiaggregatory activity of the vascular wall with thrombin	1.54±0.05	1.63±0.08 p<0.01	1.60±0.12 p<0.05	1.56±0.06 p<0.05	1.53±0.05
index antiaggregatory activity of the vascular wall with ristomycin	1.54±0.07	1.64±0.12 p<0.01	1.60±0.04 p<0.05	1.56±0.05 p<0.05	1.53±0.08
index antiaggregatory activity of the vascular wall with epinephrine	1.68±0.12	1.76±0.09 p<0.01	1.72±0.05 p<0.05	1.68±0.09 p<0.05	1.68±0.02 p<0.05
index antiaggregatory activity of the vascular wall with ADP + epinephrine	1.46±0.04	1.57±0.08 p<0.01	1.54±0.05 p<0.05	1.49±0.09 p<0.05	1.45±0.08
index antiaggregatory activity of the vascular wall with ADP +collagen	1.38±0.02	1.47±0.08 p<0.01	1.43±0.07 p<0.05	1.39±0.03 p<0.05	1.39±0.08
index antiaggregatory activity of the vascular wall with epinephrine + collagen	1.50±0.04	1.60±0.11 p<0.01	1.57±0.04 p<0.05	1.52±0.05 p<0.05	1.49±0.08
index antiaggregatory activity of the vascular wall with ADP + thrombin	1.35±0.06	1.46±0.21 p<0.01	1.43±0.18 p<0.05	1.38±0.16 p<0.05	1.36±0.15
index antiaggregatory activity of the vascular wall with ADP+ collagen + epinephrine	1.33±0.08	1.41±0.22 p<0.01	1.39±0.16 p<0.05	1.35±0.13 p<0.05	1.33±0.08
index antiaggregatory activity of the vascular wall with ADP+ thrombin+ epinephrine	1.31±0.09	1.39±0.17 p<0.01	1.36±0.15 p<0.05	1.32±0.09 p<0.05	1.31±0.11

index antiaggregatory activity of the vascular wall with ADP+ collagen + thrombin + epinephrine	1.28±0.10	1.36±0.23 p<0.01	1.33±0.17 p<0.05	1.30±0.14 p<0.05	1.29±0.13
Antithrombin III, %	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
Antithrombin III activity after temporary venous occlusion,%	146.2±0.06	170.5±0.17 p<0.01	157.0±0.13 p<0.01	157.7±0.11	160.7±0.08 p<0.05
The index of anticoagulant activity of the vascular wall	1.34±0.05	1.39±0.12 p<0.01	1.37±0.07 p<0.05	1.35±0.08 p<0.05	1.34±0.04
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
Time of spontaneous euglobulin lysis after temporary venous occlusion, minutes	246.5±0.19	233.0±0.29 p<0.01	251.5±0.19 p<0.01	242.5±0.21 p<0.01	233.4±0.15 p<0.01
The index of fibrinolytic activity of the vascular wall	1.45±0.07	1.53±0.17 p<0.01	1.50±0.13 p<0.05	1.47±0.06 p<0.05	1.44±0.02 p<0.05

Note: p - reliability of ontogenetic dynamics of the indicator.

Milk and vegetable nutrition calves showed high integrity of the endothelial lining, as indicated by a low level of endotheliocythemia (1.7±0.05 cells/µl at 31 days of life, 2.1 ± 0.03 cells/µL for 45 days and 1.8±0.04 cells/µl for 90 days).

During the phase of dairy-vegetative nutrition, an episode of an increase in the index of antiaggregatory activity of the vascular wall with all the inducers applied and their combinations to 45 days of life was recorded in the calves taken under observation (Table). The greatest increase in the index of antiaggregatory activity of the vascular wall was noted for ADP due to the maximum slowing of platelet aggregation with this agonist in a sample with temporal venous occlusion. Somewhat lower was the level of the index of antiaggregatory activity of the vascular wall with adrenaline and collagen. Even lower was the index of antiaggregatory activity of the vascular wall with thrombin (by 45 days, 1.63±0.08) and ristomycin (by 45 days, 1.64±0.12), the values of which were subsequently reduced to the end of the phase of milk and vegetable nutrition in the wake of a decrease in aggregation activity of platelets, which was reflected in the lengthening of platelet aggregation with temporary venous occlusion. Values of the indices of aggregation activity of the vascular wall with the simultaneous use of several inductors in absolute values were lower, but their dynamics had the same regularity as the index of antiaggregatory activity of the vascular wall with isolated agonists - increased to 45 days, followed by a decrease to 90 days of calves' life.

In the blood of healthy calves from the 31st to the 45th day of life, a significant increase in the level of antithrombin III by 12.5% was noted, followed by a decrease to 60 days and the subsequent tendency to increase (table). This was accompanied by a peak increase in the production of anticoagulants to the 45th day in the endothelial cells of the production of anticoagulants, followed by a return of the content of antithrombin III of vascular origin in plasma to the level of 31 days (the index of anticoagulant activity of the vessel wall by 90 days 1.34±0.04).

In all the observed calves, a significant acceleration of the spontaneous euglobulin lysis time by 11.6% was found by 45 days and its subsequent deceleration to the end of the phase to values similar to the initial ones. In this case, the secretion of tissue plasminogen activators, provoked by temporal ischemia of the venous wall, in calves during the phase of dairy-vegetative nutrition was compensated by 45 days (the index of fibrinolytic activity of the vascular wall increased by 5.5%) with a rapid decrease towards the end of the phase (fibrinolytic index activity of the vascular wall decreased by 6.2%).

Thus, in healthy calves in the middle of the phase of dairy-vegetative nutrition, there is a short-term increase in the hemostatic activity of the vascular wall and its subsequent rapid return to the level characteristic for the beginning of this phase of individual development.

DISCUSSION

The phase of milk and vegetable nutrition in calves indicates a stage of ontogenesis, which determines the adaptation of animals to the beginning of feeding with plant foods, with a gradual decrease in the intake of milk in their gastrointestinal tract [24,25]. A prominent role in this process is played by the functional activity of the vessel wall, which supports the haemostatic homeostasis of the growing animal [26,27]. Being multifunctional in terms of hemostasis control, the vascular wall largely determines the liquid properties of blood as a result of the synthesis in it of substances that limit platelet aggregation, the process of coagulation and stimulating fibrinolysis [28,29].

The peak increase in lipid peroxidation activity in calves in the calves by the 45 days of life increased their endothelial cell alteration in these periods, which was accompanied by compensatory enhancement of hemostatically significant substances in the vessels, followed by restoration of these parameters at the level close to the baseline by the end of the phase [30,31].

In healthy calves during the phase of milk and vegetable nutrition, an episode of strengthening the control of the vessel wall over the 45 days of life of the vascular wall control over the adhesive capacity of blood plates was revealed as a result of increasing depressive influences from the vascular wall to the number of collagen receptor glycoproteins Ia-IIa and VI on the platelet membrane, judging on the lengthening of the time of platelet aggregation with collagen in conditions of temporary venous occlusion.

As a result of a gradual short-term episode of the increase in the synthesis of the vascular wall of natural antiplatelet agents, a temporary weakening of the fixation of strong aggregation agonists (collagen and thrombin) is achieved with their receptors on the platelet membrane, whose activity at these times increases [32,33]. This is a deterrent to the activity of phospholipase C of the blood platelets, inhibiting the phosphoinositol pathway of platelet activation and phosphorylation of proteins in the contractile system [34, 35]. Due to the brief increase in the calves of milk and vegetal nutrition in the wall of the prostacyclin synthesis vessel and nitric oxide during 45 days of life, the effect of weak aggregation inducers (ADP and adrenaline) on the platelets (36) decreasing in expression of fibrinogen receptors (GPII-IIIa) and weakening the functionality of phospholipase A2, which releases arachidonic acid from the phospholipids of platelet membranes [37, 38]. Decrease to 90 days of life due to the adaptation of the calves to plant food aggregation ability of platelets is accompanied by a weakening of their antiaggregatory capacity of the vascular wall with respect to isolated inducers and especially when combined with them. This indicates a weakening of the tension in the primary hemostasis that has arisen for 45 days while maintaining a balance of pro- and antiaggregational influences [39].

A great importance in providing adequate general atrombogenic ability of the vascular wall in calves of dairy-vegetative nutrition also belongs to a peak increase in the formation of anticoagulant and fibrinolytic substances (AT-III and tissue plasminogen activator) by 45 days, the amount of which returns to the level of outcome by the end of this phase ontogeny [40].

CONCLUSION

Thus, in the calves, a short-term increase in antiaggregation, anticoagulation and fibrinolytic activity of the vascular wall is observed for 45 days of life, contributing to a limited peak in aggregation and hemocoagulation as a result of the change in the composition of the feed, ensuring the most complete adaptation of the animal at this stage of ontogeny.

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