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CALCIUM- AND MAGNESIUM-PROTEIN COMPLEXES OF KERATIN FORMATIONS IN THE BLOOD OF FARM ANIMALS IN CONNECTION WITH DEVELOPMENT AND PRODUCTIVITY

КАЛЬЦІЙ- І МАГНІЙ-БІЛКОВІ КОМПЛЕКСИ КЕРАТИНОВИХ УТВОРЕНЬ В КРОВІ СІЛЬСЬКОГОСПОДАРСЬКИХ ТВАРИН У ЗВ'ЯЗКУ З РОЗВИТКОМ ТА ПРОДУКТИВНІСТЮ

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Abstract. *Research results indicate that natural labile protein biocomplexes of calcium, which are formed by the type of ion exchange adsorption, constantly occur in the body of farm animals. They exist in the composition of wool, hoof and head horn. Hair keratins are especially rich in calcium in young animals. It has been established that all keratin formations in farm animals contain magnesium and calcium. Most of all calcium (400-200 mg%) is in the dry matter of the wool and less (100-150 mg%) - in the head and hoof horn. With age, its content decreases on average from 400-500 to 200-250 mg% per dry substance. This is especially noticeable in the first 4-5 months of life of calves after the change of juvenile hair cover. Bovine head horn keratins that formed at a young age were also found to be significantly richer in calcium than those that formed later. Calcium enrichment of wool and horn keratins was also noted in young animals. With age, it noticeably decreased. In contrast, the content of more stable calcium and magnesium-protein complexes in the blood of calves increased in the first months of life. It was higher under favorable seasonal feeding and maintenance conditions and sharply decreased during disturbances or during periods of increased physiological stress.*

Key words: *keeping, feeding, animals, keratins, calcium, magnesium, wool, hoof.*

Introduction.

An important role is played by the research of biocomplexes of calcium and magnesium with serum proteins and keratins in farm animals. In a number of works [1, 2, 6], the conditions of their occurrence and stability were investigated. It is shown that they easily occur during the precipitation of proteins in a neutral environment. In this regard, almost all the calcium and magnesium of milk and blood serum is found in the precipitates of proteins obtained under the action of acetone and alcohol, and the calcium of milk is precipitated together with casein under the action of rennet in a neutral environment. Significant amounts of calcium and magnesium cations added prior to precipitation are also found in protein precipitates. The main mass of metal-protein complexes that are formed in this case. Labile: calcium and magnesium cations are 80-95% displaced from them by hydrogen ions during

washing of sediments with acid solutions. Thanks to this, during precipitation with acetic (casein), as well as trichloroacetic and sulfosalicylic acids (whey proteins), only up to 20% of the total calcium content is found in protein sediments. Like a hydrogen ion, sodium and ammonium ions taken in high concentrations displace calcium from compounds with proteins. Most of these labile complexes are formed as a result of ion exchange adsorption of calcium cations on protein sediments. They are absent in native biological fluids.

The dynamics of biocomplexes of magnesium and calcium with serum proteins, which are not destroyed by the action of sulfocation, is followed in the paper [4]. In autumn, in young cattle older than six months with optimal physiological condition, 40-50% of serum magnesium and calcium is in the composition of biocomplexes with proteins. At this time, the free forms of both cations prevail over the bound ones by no more than 1.5 times. In the spring, the closer to the end of wintering and the more depleted vitamin reserves in the body, the less biocomplexes of magnesium and calcium remain in the blood of young animals.

Research results.

At the same time, we found that from 5 to 30% of calcium and up to 60% of magnesium in blood serum can be bound into strong natural biocomplexes with native proteins. They are not destroyed by precipitation with trichloroacetic acid, as well as under the conditions of calcium binding by ammonium oxalate.

The dynamics of biocomplexes of this stable type in the blood of farm animals in connection with their development and productivity are described in works [3, 5, 7]. A sharp change in their content was established in connection with the processes of lactation and egg production.

It should be noted that in the blood serum of cattle, analytical methods revealed calcium biocomplexes, which have a slightly greater lability. Leaving biocomplexes in solution, they removed free calcium from blood serum by adsorption. From 14 to 45% of calcium is not absorbed by the cationite and, accordingly, is part of the native complexes with a higher stability constant than those formed on the surface of the ion exchange resin. The amount of calcium not adsorbed by the cationite in the blood of cows is on average two times more than in the sediments under the action of trichloroacetic acid. In addition to the stable compounds of calcium with proteins described above, it contains its biocomplexes, which have sufficiently high stability constants, but can be destroyed by acids. They are not completely opened in protein precipitates obtained by using acid precipitants. Calcium is equally distributed between both forms of complexes.

Research results indicate that natural labile protein biocomplexes of calcium, which are formed by the type of ion exchange adsorption, constantly occur in the body of farm animals. They exist in the composition of wool, hoof and head horn. The keratin base of these formations, like synthetic ionites, is insoluble in water and organic solvents and has a permanent internal structure. Free amino and carboxyl groups of keratins give them the properties of polyfunctional ions, which are able to form bonds with divalent cations.

It has been established that all keratin formations in farm animals contain magnesium and calcium. Most of all calcium (400-200 mg%) is in the dry matter of

the wool and less (100-150 mg%) - in the head and hoof horn. Shredded head and hoof horn, like wool, actively absorbs calcium ions from aqueous solutions. These artificial and natural calcium complexes are destroyed at a sufficiently high concentration of hydrogen, sodium and potassium ions.

Numerous features of the physiological state of animals significantly affect the ability of their proteins to form biocomplexes of magnesium and calcium of all characterized types. A spring decrease in the content of magnesium biocomplexes was also observed in adult lactating cows. Here it developed, moreover, during lactation and was detected in animals examined in the same season of the year, at different stages of the productive cycle. The connection with the development and productivity of animals was also revealed during the study of keratin biocomplexes of calcium, built according to the type of ion exchange adsorption. It was found that with a high content of calcium in the wool of cows, their newborn calves differ in the same sign. So, binding of calcium by hair keratins in the fetus and the mother is regulated by some common factors.

Hair keratins are especially rich in calcium in young animals. With age, its content decreases on average from 400-500 to 200-250 mg% per dry substance. This is especially noticeable in the first 4-5 months of life of calves after the change of juvenile hair cover. Bovine head horn keratins that formed at a young age were also found to be significantly richer in calcium than those that formed later.

With an incorrect ratio with phosphorus or with a lack of calcium in the feed, calcium accumulates in the wool of cows [8,9]. According to the author, this is accompanied by its disappearance from the composition of bones and blood serum. He observed a similar condition in cows of the Dutch breed with a content of more than 240 mg% calcium in black hair. In healthy animals, they contained from 180 to 235 mg% of this cation.

Studying calcium in the wool of the farm's black-spotted cows, we found a favorable physiological state in most animals with an annual milk yield below 4,500 kg. In cows with higher productivity, they are noted only in 20% of cases.

In highly productive animals from farms in the Chernivtsi region, with a milk yield of less than 6,000 kg, this condition was also found in only 30% of the herd. And, finally, in particularly productive animals of this farm (more than 6,000 kg of milk per year), the level of calcium in the wool was always higher than normal.

Thus, disturbances of mineral metabolism associated with feeding or increased productivity in cattle were accompanied by the accumulation of calcium in the labile keratin biocomplexes of their wool.

Conclusions.

Calcium enrichment of wool and horn keratins was also noted in young animals. With age, it noticeably decreased. In contrast, the content of more stable calcium and magnesium-protein complexes in the blood of calves increased in the first months of life. It was higher under favorable seasonal feeding and maintenance conditions and sharply decreased during disturbances or during periods of increased physiological stress.

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Анотація. *Результати досліджень вказують на те, що в організмі сільськогосподарських тварин постійно виникають природні лабільні білкові біокомплекси кальцію, які утворені за типом йоннообмінної адсорбції. Вони існують в складі шерсті, копитного і головного рогу. Кератини шерсті особливо багаті кальцієм у молодих тварин. Встановлено, що всі кератинові утворення у сільськогосподарських тварин містять магній і кальцій. Більше всього кальцію (400-200 мг%) знаходиться в сухій речовині шерсті і менше (100-150 мг%) – в головному і копитному рогові. З віком вміст його знижується в середньому від 400-500 до 200-250 мг% на суху речовину. Особливо різко це помітно в перші 4-5 місяців життя телят після зміни ювенального волосяного покриву. Кератини головного рогу великої рогатої худоби, які сформувались в молодому віці, також виявились значно багатшими на кальцій, ніж ті, які з'явились пізніше. Збагачення кальцієм кератинів шерсті і рогу відмічалась також у молодих тварин. З віком вона помітно знижувалась. На противагу цьому вміст більш стабільних кальцій- і магній-білкових комплексів у крові телят наростав в перші місяці життя. Він був більш високим при сприятливих сезонних умовах годівлі і утримання та різко знижувався при порушеннях або в періоди підвищеного фізіологічного напруження.*

Ключові слова*: утримання, годівля, тварини, кератини, кальцій, магній, шерсть, копито.*