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VITAMIN E AND C IN THE BLOOD PLASMA OF COWS AND THEIR CALVES FED FROM BUCKETS

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Abstract

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The vitamin E and C levels were studied in the blood plasma and colostrum of 40 cows and in the blood plasma of their calves until the age of 3 months. The assays were made in winter. The vitamin E levels prior to and after parturition did not show appreciable differences while the vitamin C levels prior to parturition were significantly lower. The vitamin E concentration in the first milk surpassed ca. 2.5 times that found in the plasma of the dams.

In the newborn calves ca. 5 times lower vitamin E plasma content was estimated than in their mothers. This amount increased gradually with ageing of the calves from the original 114 μg/100 ml prior to feeding colostrum up to 250 μg/100 ml at the age of 3 months. The vitamin E levels of the 3-month old calves did not reach half the values found in their mothers. The vitamin E protects the vitamin A from oxidation and it contributes to formation of antibodies. Therefore it seems reasonable to enrich the food (milk) for calves in the first days of life.

Highest vitamin C level in the blood plasma of calves was found in the first days after birth. Low vitamin C levels were then determined in the 6-week old and 3-month old calves, i. e. in the period of high incidence of the respiratory syndrome.

Cow, calf, blood plasma, colostrum, age.

Hypovitaminosis E presents a serious problem in all categories of cattle being especially grave in calves. The growing animals require this vitamin for the function of endocrine glands, and of cardiac, striated and smooth muscles. Its defficiency results in impaired fertility both in females and males (Horwitt 1976). In hypovitaminosis E impairment of the membranes, their higher permeability and lower resistance occur (Fontaine and Valli 1977). Vitamin E protects also the vitamin A from oxidation in the digestive tract, increases its absorption and availability (Kusin et al. 1974). Recently, a certain importance has been ascribed to this vitamin in the formation of antibodies whose synthesis in dogs was enhanced by vitamin E (Sheffy and Schultz 1978).

The most frequent symptom of vitamin E defficiency in ruminants is the muscular dystrophy with changes in the skeletal muscles of young animals. On this disease numerous reports from various countries are available (Kursa 1969, 1973; Vrzgula et al. 1972, 1975; Kováč et al. 1974; Pouka 1968; Lyford and Colby 1967).

The level of vitamin E in the blood serum of newborn calves was found to oscillate between 29 μg% and 80 μg% (Kováč 1978). Higher values were estimated by Blaxter and Brown (1959).

The vitamin E levels in the blood serum of cows are substantially higher than those of their calves. In grazing cows 919 μg/100 ml of vitamin E were found (Hidiroglou et al. 1973). Similar results were obtained also by Samochin et al. (1975), and Caravaggi (1969) found as much as

1600 μg/100 ml of vitamin E. In Black-spotted cattle the serum levels of vitamin E oscillated between 276 and 1113 μg/100 ml (Kováč 1978).

Similarly, higher amount of the vitamin E was repeatedly detected in colostrum with 300–400 μg/100 ml regarded as physiological optimum (Kieferle et al. 1953). In colostrum from the first milking 744 μg/100 ml vitamin E were estimated (Samochin et al. 1975).

The alpha-tocopherol in the blood plasma of cows is largely influenced by feeding and the stage of pregnancy. In the late-pregnant cows the tocopherol levels were up to 55 % lower than in lactating cows (Dvořák et al. 1978).

At present, in human and veterinary medicine great attention has been paid to the relationship of vitamin C and resistance of the organism to respiratory diseases (Pauling 1972; Jagoš et al. 1977). The need for vitamin C is higher during stress, in infectious diseases, trauma, hormonal disturbances and physical load of the organism (Mašek 1977). During stress, the small tissue reserves of ascorbic acid are probably used up.

Among ruminants, the milk-fed calves are the most susceptible to the lack of vitamin C (Rosenberg 1970), and especially in the first weeks of life they are highly dependent upon exogenous source of ascorbic acid (Lundquist and Phillips 1943).

The level of ascorbic acid in the blood serum of calves ranged from 0.3 to 1.4 mg/100 ml (Dvořák 1964). According to this author it is under normal conditions probably not necessary to supply the calves with extra vitamin C. The level of ascorbic acid ranging from 0.7 to 1.3 mg/100 ml in 1-month old calves can be considered physiological (Rosenberger 1970). In adult cattle the serum content of ascorbic acid ranged from 0.30 to 2.91 mg/100 ml (Dvořák 1966). Significantly lower ascorbic acid amount was found in calves suffering from both acute and chronic stages of bronchopneumonia as compared to the control animals (Jagoš et al. 1977).

Material and Methods

In the experiment, 40 late-pregnant cows of the Czech Spotted breed and their 42 calves were employed. The animals were housed in a large-scale cowhouse for 600 animals. The clinical examination and blood sampling of cows were made 2–5 weeks prior to and 2–4 weeks after the parturition. The dams were catheterized for urine samples and a pooled sample of the first milk was collected.

Immediately after birth the calves were placed individually into cages and at the age of 14 to 18 days to a separate calf house. Colostrum was fed twice daily (4–5 l/day) from buckets and from the 6th day a milk substitute Laktosan A was fed (6–7 l/day). A concentrated feed mixture TK-1 was fed from the day 11 and high-quality meadow hay was added at the age of 3 weeks. The body mass of calves prior to their first feeding averaged 42.2 kg. Their health status was followed up to the age of 3 months. The calves were blood-sampled prior to and after ingestion of colostrum at the age of 1, 3, 7, 14, 21, 42, 56 and 84 days.

The vitamin E levels in blood plasma and colostrum were determined spectrofluorometrically (Bouda and Jagoš 1979). The ascorbic acid in blood plasma was determined using the micromethod by Roe and Kuether (1943) modified by Bessey (1947). The method is based on colour product occurring during the reaction of oxidized ascorbic acid with dinitrophenylhydrazine.

The results were evaluated on a Hewlet-Packard computer, model 9810 A. For statistical analysis the variance analysis and the Duncan test were used.

Results

The vitamin E and C levels in the blood plasma of cows are given in Table 1. There were no differences in the plasma vitamin E levels in cows prior to and after parturition while the vitamin C levels were significantly ($P < 0.01$) lower in dams before parturition.

Age-dependent changes in the average concentration of vitamins E and C in the blood plasma of calves are given in Table 2. The vitamin E level in the blood plasma of calves prior to the intake of colostrum was about 5 times lower than in their mothers. After the intake of colostrum it gradually increased. On the other hand, the vitamin C content in the blood plasma of calves both before and after ingestion of colostrum surpassed substantially that found in their mothers. At about the age of 14 days the vitamin C level in the plasma of calves and their dams

Table 1
Mean concentration of vitamin E and vitamin C in the blood plasma of cows before and after parturition

Parameter	Prepartum cows	Postpartum cows	*P*
Vitamin E (μg/100 ml)	570.0 ± 180.0	593.5 ± 123.0	–
Vitamin C (μg/100 ml)	610.0 ± 170.0	760.0 ± 120.0	++

Note $P < 0.01 = ++$
$P > 0.05 = -$

Table 2
Mean vitamin E and C levels in the blood plasma of calves

Animals	Age days	Vitamin E (μg/100 ml)		Vitamin C (μg/100 ml)	
		$\bar{x}$	s	$\bar{x}$	s
Cows	Prepartum	570.0	180.0	610.0	170.0
Calves	Without colostrum	114.7	74.9	1030.0	270.0
	1	128.0	50.3	1010.0	230.0
	3	127.7	45.2	770.0	210.0
	5–7	131.5	50.6	630.0	170.0
	14	140.0	37.6	620.0	160.0
	21	154.1	40.9	600.0	160.0
	42	176.5	43.9	560.0	80.0
	56	223.4	100.8	500.0	90.0
	84	250.6	97.8	500.0	120.0

were approximately the same. From the 6th week up to the age of 3 months the vitamin C level in the blood plasma of calves decreased.

The colostral vitamin E level averaged 1339 ± 1046 μg/100 ml, which was about 2.5 times more than the values found in the plasma of these dams.

Discussion

The results of the present experiment show sufficient level of vitamin E in the blood plasma of the dams before and after parturition possibly due to parenteral administration of the vitamin prior to parturition. In this experiment no appreciable differences in the plasma vitamin E level before and after parturition were detected, while Dvořák et al. (1978) reported on considerable decrease in the blood plasma levels of this vitamin in the period of 3—23 days before parturition. However, the experimental conditions of these two studies differed. In our study, the vitamin E levels were followed 2—5 weeks before parturition and not in the probably most critical period, and the dams were treated with one dosis of vitamin preparation containing also vitamin E. The vitamin E levels found in the blood plasma of dams in the present study were substantially higher than those found by Lyford and Colby (1967) but they correspond to the values found by Samochin et al. (1975), Dvořák et al. (1978) and Kováč (1978).

An enhanced transfer of vitamin C into colostrum occurs presumably prior to parturition as indicated by its decreased plasma content in our dams. Comparison of the high vitamin E concentration in colostrum with its low amount in the blood plasma of newborn calves shows clearly the importance of high-quality colostrum for the young organism.

The present results show that the calves are born with low blood plasma vitamin E level amounting about one fifth that of their mother's blood plasma. Similar findings reported also Blaxter and Brown (1952) who observed the vitamin E content to increase gradually with ageing of the calves from 114 μg/100 ml prior to feeding colostrum to 250 μg/100 ml at the age of 3 months. Nevertheless, this amount of vitamin E did not reach half the values found in the cows. Much lower vitamin E content in the blood plasma of calves prior to feeding colostrum were found by Kováč (1978). This author, however, observed a more pronounced rise in the vitamin E amount after feeding colostrum as compared to our results.

On the basis of the present study indicating low vitamin E content in the blood plasma of calves up to the age of 6 weeks it seems reasonable to supply them with this vitamin in the first days of life. Moreover, vitamin E is also known to contribute to the antibody formation Sheffy and Schultz (1978) and protect the vitamin A from oxidation.

The vitamin C content in the blood plasma of calves was highest before the first ingestion of colostrum and on the first day of colostral nutrition. Later, a decrease in the vitamin C plasma content occurred, being particularly pronounced from the 6th week until the age of 3 months. In this period of low vitamin C reserves also the highest incidence of the respiratory syndrome occurs, and the calves should be provided with additional vitamin C as indicated by our results and field practice.

Hladiny vitamínů E a C v krevní plazmě krav a jejich telat napájených z nádob

Hladiny vitamínů E a C byly studovány v zimním období v krevní plazmě a kolostru 40 krav a v krevní plazmě jejich telat do stáří 3 měsíců. V hladinách vitamínu E u krav před a po porodu nebylo významných rozdílů, zatímco vitamín C byl významně nižší u krav před porodem. Koncentrace vitamínu E v kolostru z prvního nádoje byla přibližně 2,5krát vyšší než v plazmě krav.

Novorozená telata mají hladiny vitaminu E přibližně 5krát nižší než jejich matky. Hladina vitaminu E v plazmě telat stoupala pozvolna se stářím telat, tj. z původních 114 μg/100 ml před podáním kolostra na 250 μg/100 ml ve stáří 3 měsíců. Hladiny vitamínu E u 3měsíčních telat nedosahovaly ani 50 % hodnoty u krav. Vitamín E chrání vitamín A před oxidací a zasahuje do tvorby protilátek a z těchto důvodů bude účelné přidávat vitamín E telatům hned v prvních dnech jejich života.

Nejvyšší koncentrace vitamínu C v krevní plazmě telat byly v prvních dnech jejich života. Nízké hodnoty vitamínu C byly nalezeny u telat ve stáří 6 týdnů až 3 měsíců, tj. v období, kdy v praxi je u telat zaznamenáván největší výskyt respiračního syndromu.

Метаболизм витаминов Е и С у коров и их телят, поенных из сосудов

Уровни витаминов Е и С изучались в зимний период в кровяной плазме и молозиве 40 коров и в кровяной плазме их телят в возрасте до 3 месяцев. Между уровнями витамина Е коров до и после отела не наблюдалось существенной разницы, между тем как витамин С был существенно ниже у коров до отела. Концентрация витамина Е в молозиве первой дойки была приблизительно 2,5 раза выше концентрации в плазме коров, настоящая разница в случае витамина С была еще более выразительной.

Уровни витамина Е новорожденных телят приблизительно в 5 раз ниже уровня их коров. Уровень витамина Е в плазме телят постепенно поднимался с возрастом телят, т. е. из первоначальных 114 мкг/100 мл до подачи молозива на более чем 250 мкг/100 мл в возрасте 3 месяцев. Уровни витамина Е телят в возрасте 3 месяцев не достигали даже 50 % величины уровня коров. Так как витамин Е защищает витамин А от окисления и вмешивается в образование антивеществ, выходит, что целесообразно его добавление телятам сразу же в первые дни их жизни.

Максимальная концентрация витамина С в кровяной плазме телят наблюдалась в первые дни их жизни. Низкие величины витамина С были выявлены у телят в возрасте 6 недель — 3 месяцев. В данном возрасте отмечается у телят также максимальное присутствие респирационного синдрома.

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