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THE INFLUENCE OF SUPPLEMENTAL VITAMIN E ON MILK YIELD, DMI, BWC, NEFA IN EARLY LACTATING DAIRY COWS

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In the study on early lactating dairy cows, it was shown the influence of vitamin E on some indices including milk yield, DMI (dry matter intake), BWC (body weight change), and NEFA (non-esterified fatty acids) while feeding diet with or without supplemental vitamin E. In control and treated group DMI had positive correlations with milk production. BWC had negative correlations with milk and DMI. NEFA had positive correlations with milk. NEFA had negative correlations with DMI and BWC. The correlations were significant for some values. These findings indicate that oral administration of vitamin E can be useful for improvement of milk yield and DMI, and reduction of BWC and NEFA in the cows.

Milk yield – DMI – BWC – NEFA – lactating cow – vitamin E

Վաղ լակտացիոն շրջանում ուսումնասիրվել է վիտամին E-ի հավելման ազդեցությունը կաթնատու կովերի այնպիսի ցուցանիշների վրա ինչպիսիք են՝ կերի չոր նյութի կլանումը, մարմնի կենդանի զանգվածի փոփոխությունները, կաթնատվությունը և արյան պլազմայի չեսթերիֆիկացված ճարպաթթուների (ՉԷՃԹ) պարունակությունը: Ինչպես ստուգիչում (առանց վիտամին E-ի) այնպես էլ փորձնական խմբում գրանցվել է դրական կորելյացիա կերի չոր նյութի կլանման և կաթնատվության միջև: Միևնույն ժամանակ նշվում է բացասական կորելյացիա նշված ցուցանիշների և կենդանի զանգվածի միջև: ՉԷՃԹ-ի արյան պլազմայի քանակը դրսևորում է դրական կորելյացիա կաթնատվության և բացասական՝ չոր նյութի կլանման և կենդանի զանգվածի փոփոխության հետ: Կորելյցիան հավաստի է որոշ մեծությունների համար: Ստացված տվյալները վկայում են վիտամին E-ի դրական ազդեցության մասին կերի չոր նյութի կլանման և կաթնատվության վրա, որը զուգորդվում է ՉԷՃԹ-ի քանակի և կենդանի զանգվածի փոփոխության նվազմամբ:

Կաթնատվություն – կերի չոր նյութի կլանում – կենդանի զանգված – ՉԷՃԹ – կաթնատու կովեր – վիտամին E

В ранний период лактации было изучено влияние скармливания витамином Е на некоторые показатели молочных коров, включая поглощение сухого вещества корма, изменение массы тела, продукцию молока и содержание НЭЖК в плазме крови. Как в контроле (без витамина Е), так и в опыте отмечалась положительная корреляция между поглощением сухого вещества корма и молочной продуктивностью. Регистрируется отрицательная корреляция между изменениями живой массы и вышеуказанными показателями. Концентрация НЭЖК в плазме крови находится в положительной корреляции с молочной продуктивностью и отрицательной с поглощением сухого вещества корма и изменением массы тела. Корреляция достоверна для ряда величин. Полученные данные указывают на положительное влияние скармливания витамином Е на поглощение сухого вещества корма и молочную продуктивность, сопровождаемое уменьшением содержания НЭЖК в сыворотке крови и изменения массы тела.

Продукция молока – поглощение сухого вещества корма – изменение массы тела – НЭЖК – лактирующие коровы – витамин Е

In early lactating dairy cows, increasing milk production greatly increases demands for energy at a time when DMI (dry matter intake) has not reached its maximum, because the increase in milk production occurs prior to a sufficient increase in dry matter intake, Therefore, dairy cows undergo tremendous adaptive changes during early lactation period. The majority of cows cannot meet their energy requirements for milk production and are forced to mobilize body fat to attempt to meet their energy needs [8]. Adipose tissue provides energy in the form of non-esterified fatty acids (NEFA) [6]. The high amount of mobilized fat enters the liver. It is converted to ketone bodies to supply energy. Thus, maintaining optimal liver function is central to the ability of cows to have a smooth early lactation period. Fat infiltration is a principal factor leading to development of fatty liver and ketosis [7]. Fatty liver and ketosis are metabolic disorders which affect lactating cows and cause economic losses due to reduction productivity. As the degree of fat infiltration increases, normal function of liver is affected adversely. The situation becomes a problem when dry matter intake does not increase sufficiently in early lactation to support energy needs and reduce fat mobilization.

Milk yield, dry matter intake (DMI), body weight change (BWC) and some metabolite concentrations in blood reflect the nutrient status and productivity of an early lactating cow.

Since vitamin E is a powerful antioxidant which can prevent lipid peroxidation and improve hepatocyte function [10, 12], we studied the influence of feeding supplemental vitamin E on correlations between milk yield (based on FCM), dry matter intake, body weight change and NEFA in early lactating dairy cows.

Materials and methods. *Cows, treatments, and data collection.* Sixteen primiparous and multiparous Holstein cows were used in our study for one month beginning five weeks postpartum. Cows were housed in individual tie stalls. Selection of cows for initializing this experiment was based on parity, milk yield of previous lactation (milk yield of dams for the cows in their first lactation) and body condition score (BCS). Therefore, the similarity of production and BCS was used as selection criterion of dairy cows for starting the study. Cows were fed for *ad libitum* intake the total mixed ration (TMR). The cows received diet with or without supplemental vitamin E (the amount of vitamin E was 4400 IU/d for treated group). The diet was formulated to production intensity, and consisted of ordinary alfalfa hay, silage, beet pulp, and concentrate (including barley, corn, canola meal, cottonseed, wheat bran, cottonseed meal, wheat grain, corn glutton meal, soybean meal, sodium bicarbonate, fat meal, limestone and vitamin-mineral supplement). The vitamin E was top-dressed onto the TMR.

Sampling and statistical analysis. Cows were milked thrice daily at 8 hour intervals, with no provision of water or concentrate while milking. Milk yield was measured everyday for all cows. The milk samples from individual cows were analyzed for milk contents. The following formula was used for the calculation of FCM (fat corrected milk) of each cow [4]: FCM= [(0·4×kg milk) + (0·15×kg milk× fat g/kg)]. Gaines's formula is an attempt to relate the energy required to produce milks of different fat contents by adjusting the yield to that of 4% butterfat milk. Samples of TMR and ort for both control and treated group were taken for analysis of dry matter. All samples were dried at 60 °C for 72 h, and then weighed to determine moisture loss. Blood samples were obtained before morning meal from the coccygeal vein on the last day of experiment and then were collected in heparinized Vacutainer tubes (heparin as anticoagulant) (Becton Dickinson, Franklin Lakes, NJ). Blood samples were placed on ice immediately following collection. Plasma was harvested after centrifugation of the blood at 3000 g for 15 min. Then they were both stored at −20 °C for 24 hours until subsequent analysis for NEFA. The NEFA was measured on "BT 1500 auto-analyzer" through spectrophotometer method, using kits produced by "Farasamed Co, Ltd. Tehran, Iran.

For statistical analysis, experimental data normality was verified, and then data were submitted to analysis of correlation, using SAS (2002) software package.

Results and Discussion. The raw data and the correlations between the values for the control and treated group (which received vitamin E) are shown in the following tables (1 & 2).

In our study, in control and treated group, DMI had positive correlations with milk (0.35 and 0.75 respectively). BWC had negative correlations with milk (-0.48 and -0.20 respectively) and DMI (-0.28 and -0.07 respectively). NEFA had positive correlations with milk (0.50 and 0.11 respectively). NEFA had negative correlations with DMI (-0.43 and -0.09 respectively) and BWC (-0.41 and -0.11 respectively). The values between 0.4 and 0.8 as well as -0.4 and -0.8 are significant.

Table 1. The influences of vitamin E on some indices in early lactation dairy cows

Groups	Control	Vitamin E
Milk (kg/d)	34.70 ± 3.57	36.75 ± 3.00
DMI (kg)	22.43 ± 2.15	23.26 ± 3.58
BW (kg)	-13.40 ± 1.85	-6.14 ± 2.54
NEFA (mmol/l)	0.32 ± 0.05	0.25 ± 0.03

Table 2. The correlation between some values in the control and treated cows (with vitamin E)

Groups	Control			Vitamin E		
Correlation	Milk	DMI	BW	Milk	DMI	BWC
DMI	0.35	----	-----	0.75 *	------	------
BWC	-0.48 *	-0.28	-----	-0.20	-0.07	------
NEFA	0.50 *	-0.43 *	-0.41 *	0.11	-0.09	-0.11

* Significant

Dairy cows during early lactation period are at high risk for different metabolic disorders, including fatty liver and ketosis [2]. Consequences of fatty liver and ketosis include losing weight, decreasing dry matter intake and milk yield [8].

To support milk production, the cows mobilizes adipose tissue, therefore NEFA concentration is elevated during early lactation which are associated with hepatic triglyceride accumulation and increased production of ketone bodies [14]. Liver uptake of NEFA is proportionate to portal blood supply [11]. The liver does not have sufficient capacity to completely dispose of NEFA through export into the blood or catabolism for energy [3]; therefore, when large amounts of NEFA are released into the blood, the liver begins to accumulate and store NEFA as triglycerides, resulting in fatty liver. Early lactating cows mostly rely on gluconeogenesis in the liver to meet their glucose requirements. But the level of blood glucose decreases during early lactation due to high demands for lactose synthesis as well as insufficient gluconeogenesis [1]. Reduction in gluconeogenesis by the liver, due to accumulation of fat in the liver, lower blood glucose levels and decrease insulin secretion, which would support greater lipid mobilization and increase rate of fatty acid uptake by the liver and increase ketogenesis [5]. An increase in plasma glucose during early lactation will likely increase insulin and decrease NEFA concentration.

In cows, plasma concentration of a-tocopherol (vitamin E) decrease during early lactation period [15], and low concentration of plasma vitamin E is associated with increased incidence of fatty liver [9]. Supplemental vitamin E can decrease inflammatory cytokine production [10] and improve liver antioxidant status in mice with fatty liver [13], supplemental vitamin E also improves liver function in early lactation cows.

In human, vitamin E supplementation significantly improved liver health in steatohepatitis patients compared to placebo [12].

The results of our study indicate that feeding supplemental vitamin E revealed tendency to decrease BWC loss, NEFA as well as increasing milk production and DMI. In this case vitamin E probably improved liver function due to increase glucose in the blood and then by stimulation of insulin secretion suppresses fat mobilization from adipose tissue. Therefore the treated group lost less weight than that of the control group. The reduction
in fat mobilization causes to decrease the amount of NEFA in the blood and consequently make the influx of NEFA into the liver slow, thus the liver has fewer problems for oxidation of NEFA, and as a consequence, accumulation of fat in the liver decreases. Besides due to improvement of liver function, more NEFA oxidized in the liver and so the level of beta-hydroxy butyric acid (BHBA)

decrease in the blood. But when NEFA increases in the blood, liver does not have the capacity to oxidize them or export them as VLDL, therefore they convert to fat and store in the liver or they convert to BHBA. when NEFA and BHBA increase in the blood the pH of blood decreases, and increase in NEFA concentration effect on hypothalamus which causes to decrease appetite (because appetite is controlled specifically by hypothalamus), and as a result, dry matter intake decreases in cows with fatty liver and ketosis, therefore DMI cannot support milk production, thus in our study, the cows in control group lost more weight compared to the treated group.

In conclusion, feeding vitamin E might be useful for early lactating dairy cows due to improvement of liver function, milk yield and DMI and reduction of BWC and NEFA.

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