Effect of Vitamin E and Fat on Serum Vitamin E and Cholesterol Levels of Newly Received Heifer Calves

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Story in Brief

One-hundred-six crossbred heifer calves were received at the Willard Sparks Beef Research Center (WSBRC) in mid-January, 2000, in order to study the effects of adding supplemental vitamin E, fat, or their combination on receiving health, weight gain, feed efficiency, and serum levels of vitamin E (alpha tocopherol) and cholesterol. Heifers were blocked by weight; within each weight block cattle were assigned to one of four dietary treatments in eight pens. The diets consisted of control, added vitamin E, added fat, or added vitamin E and fat. Health and performance results have been reported (Choat et al., 2000). Venous blood samples were collected on d 0, 14, 28, and 42 from a random subset of 4 head/pen; serum was separated from whole blood and analyzed for vitamin E and cholesterol. Heifers were examined daily for signs of bovine respiratory disease (BRD). A regimen of anti-microbial drugs prescribed by veterinary personnel was used when animals met specific criteria for morbidity. Of the heifers sampled for venous levels of vitamin E and cholesterol (n = 32), 47% received one anti-microbial treatment and 22% received a second anti-microbial treatment. The addition of vitamin E in this experiment increased serum levels of vitamin E over the 42-d experimental period. Additional fat had no effect on serum vitamin E levels however, fat and vitamin E combined did cause an increase in cholesterol levels from d 0 to 28 and d 0 to 42 compared with controls and heifers fed vitamin E.

Key Words: Serum Vitamin E, Cholesterol, Receiving Cattle

Introduction

Vitamin E, an antioxidant, is the body's primary natural defense against free radicals formed from normal metabolism or other mechanisms that may be associated with disease and stress. Vitamin E is a lipid soluble vitamin that is found in most all lipid membranes; however, once a molecule of vitamin E interacts to stop the destructive nature of free radicals and oxidation by receiving or donating an electron, the molecule is rendered unavailable. This has lead investigators to the hypothesis that additional vitamin E may be necessary for animals subjected to extraordinary levels of stress and disease such as that of the bovine respiratory disease (BRD) complex associated with shipping-stressed calves. Numerous studies have been conducted to evaluate the benefits of supplementing newly received, stressed cattle with additional vitamin E or other antioxidants (Gill et al., 1986; Hays et al., 1987). These studies have shown improvements in performance and immune system function of shipping-stressed calves backgrounded on a high-roughage diet. Stovall et al. (1999) fed Agrado™ to shipping stressed heifer calves and observed decreased morbidity and fewer repulls when calves were fed Agrado™ vs negative controls. When examining cattle treated once vs no treatment for BRD, Stovall et al. (2000) observed that cattle receiving one treatment had decreased carcass value compared with those not treated for BRD, which gives us additional incentive to improve the health of receiving cattle. In addition, Carter et al. (2000) observed a $0.38/hd direct advantage

for cattle receiving 2000 I.U. vitamin E for 28 d calculated as medical costs minus the cost of providing vitamin E. Therefore the benefits of additional vitamin E have been realized. Little information is available on the effects of adding fat to diets with vitamin E levels beyond those recommended by the National Research Council (1996) in order to possibly enhance the benefits of additional vitamin E, a fat soluble vitamin.

Materials and Methods

One truckload of heifer calves (n = 106; BW = 382 ± 32 lb) was purchased by order buyers from auction markets in Oklahoma and Arkansas and shipped to the Willard Sparks Beef Research Center, Stillwater, OK. Upon arrival at the feedlot, calves were ear tagged and weighed individually (382 ± 32 lb). Cattle were then placed into a large pen and offered free choice access to long-stem prairie hay and water over night. On the morning after arrival, heifers were processed as follows: 1) individual weights recorded; 2) vaccinated with BRSV VAC 4®, IM, Vision 7®, SQ, and treated for internal and external parasites using Ivomec injectable®, SQ; 3) started on antibiotic treatment if clinical signs of illness were detected; 4) a hospital card was initiated for calves diagnosed as morbid; 5) allocation to assigned pens, based on arrival weight; and 6) revaccinated with BRSV VAC 4® 14 d post arrival. Cattle were blocked into two weight groups and were assigned to eight pens holding 10 to 14 animals each. Housing consisted of 40' x 100' feedlot pens with fence line cement bunks. Adjacent pens shared automatic waterers.

Treatment. During the 42-d receiving period, cattle were fed one of four receiving diets that were balanced to meet or exceed NRC (1996) recommendations. The diets consisted of 32% soybean hulls, 27% whole corn, 16% wheat midds, 10% cottonseed hulls, and 14% supplement. Two percent yellow grease was added in place of corn to treatments with added fat, and 2% of a Vit E premix was added in place of wheat midds to supply approximately 1300 additional I.U. of vitamin E /hd/d to the vitamin E and vitamin E and fat treatments. Bunks were read at approximately 0700, 1 h before feeding, to determine the amount of feed to be offered that day.

Health Management. After processing, cattle were checked once daily for clinical signs of illness. Animals that showed clinical signs of illness were moved to the processing area where body temperature was determined and a severity score (slight, moderate, or severe) based on subjective evaluation was assigned. Animals with severity scores of "slight or moderate" required a body temperature of 104°F or greater to be considered "sick". However, if animals had a severity score of "severe" they were automatically considered "sick" without a body temperature requirement. Following medical treatment heifers were returned to their original pens. During the 42-d receiving trial animals that were chronically ill and(or) lame were removed from the experiment.

Blood Sampling. A subset of 4 hd/pen or 8 hd/treatment was randomly chosen at the initiation of the experiment to be sampled on d 0, 14, 28, and 42. The heifers were identified during individual weight collection at which time 30 mL of whole blood was collected via jugular venipuncture. The whole blood was allowed to coagulate overnight and then centrifuged at 2500 x g for 15 min, serum was separated following centrifugation and immediately frozen at –40°C for later analysis of vitamin E and cholesterol.

Weight Determination. Heifers were weighed both by pen and individually on d 0, 14, 28, and 42 of the trial. At the beginning and end of the 42-d receiving trial, the cattle were taken off feed and water for approximately 16 h before the weight was taken to establish initial and final shrunk weights.

Statistical Analysis. Due to variation in initial vitamin E and cholesterol concentrations, change in vitamin E and cholesterol concentration over time was analyzed. Change was calculated for Periods 2, 3, and 4 as: Period 2) per 2 conc. minus per 1 conc.; Period 3) per 3 conc. minus per 1 conc.; and Period 4) per 4 conc. minus per 1 conc. Data were analyzed using the Mixed procedure and a least squares model which included treatment (SAS Inst. Inc., Cary, NC) with a repeated measures statement and autoregressive as the covariance structure (animal = experimental unit).

Results and Discussion

Concentrations of vitamin E and cholesterol are presented in Table 1. Differences in initial concentrations of vitamin E and cholesterol were accounted for by examining the change in concentration over time. The cause of variability in initial concentrations of vitamin E and cholesterol is unknown as is the background and origin of the heifers used in this experiment. Potential reasons for variability might include differences in previous nutrition and/or stress. Changes in concentrations of vitamin E and cholesterol are summarized in Table 2. A treatment by period interaction occurred (P<.01) for change in vitamin E concentration, which can be attributed to the fact that heifers fed additional vitamin E had a lower reduction in vitamin E concentration over time. In heifers fed fat and vitamin E plus fat, cholesterol concentrations returned to initial values or greater by d 42 and 28, respectively, whereas cholesterol concentrations remained lower than initial concentrations throughout the 42-d trial in heifers not fed fat.

Table 1. Results of laboratory analysis for serum concentrations of cholesterol and vitamin E[a]

	Treatments[b]				
	CON	FAT	E	FAT + E	S.E.M.
Concentration					
Cholesterol-d 0, mg/dl	154.00[d]	102.38[ef]	121.88[de]	79.00[f]	14.04
Cholesterol-d 14, mg/dl	69.25	51.13	52.25	59.75	14.04
Cholesterol-d 28, mg/dl	92.88	85.71	84.00	101.00	15.01
Cholesterol-d 42, mg/dl	100.71	100.86	91.14	113.12	15.01
Cholesterol (time)[c]	LQC	QC	QC	LC	
Vitamin E-d 0, ug/ml	5.48[d]	3.74[e]	3.36[e]	2.64[e]	.50
Vitamin E-d 14, ug/ml	1.94[d]	1.35[d]	2.67[d]	2.02[d]	.50
Vitamin E-d 28, ug/ml	1.18[d]	.78[d]	2.82[e]	2.71[e]	.53
Vitamin E-d 42, ug/ml	.75	.58	1.71	1.26	.53
Vitamin E (time)[c]	LQC	LQ	L	C	

[a]Results taken from PROC MIXED analysis and represent least squares means (treatment x period).
[b]CON=no added fat or vitamin E; FAT=2% added yellow grease; E=1300 I.U. added vitamin E; FAT + E=2% added fat and 1300 I.U. added vitamin E.
[c]L = linear (P<.05); Q = quadratic (P<.05); C = cubic (P<.05).
[d,e,f]Means within a row lacking common superscripts differ (P<.05).

Table 2. Results of laboratory analysis for change in serum concentrations of cholesterol and vitamin E[a]

	Treatments[b]				
	CON	FAT	E	FAT + E	S.E.M.
Change in concentration[c]					
Cholest. (d 14-d 0), mg/dl	-84.75[e]	-51.25[ef]	-69.62[ef]	-19.25[f]	21.26
Cholest. (d 28-d 0), mg/dl	-61.13[e]	-14.93[ef]	-37.88[e]	22.00[f]	21.43
Cholest. (d 42-d 0), mg/dl	-52.53[e]	.38[ef]	-29.52[e]	34.12[f]	21.43
Cholest. (time.)[d]	L	L	LQ	LQ	
Vit-E (d 14-d 0), ug/ml	-3.54[e]	-2.40[ef]	-.68[f]	-.62[f]	.65
Vit-E (d 28-d 0), ug/ml	-4.30[e]	-2.81[e]	-.54[f]	-.06[f]	.66
Vit-E (d 42-d 0), ug/ml	-4.64[e]	-3.01[ef]	-1.77[f]	-1.38[fg]	.66
Vit-E (time)[d]	L	NS	LQ	Q	

[a]Results taken from PROC MIXED analysis and represent least squares means (treatment x period)
[b]CON=no added fat or vitamin E; FAT=2% added yellow grease; E=1300 I.U. added vitamin E; FAT + E=2% added fat and 1300 I.U. added vitamin E.
[c]Change in concentration = Periods 2, 3, and 4 minus Period 1 for each treatment
[d]L = linear (P<.05); Q = quadratic (P<.05); C = cubic (P<.05)
[e, f, g] Means within a row lacking common superscripts differ (P<.05).

When examining main effects of treatment, controls had a greater negative change in vitamin E concentration equaling a greater decrease in vitamin E concentration compared with heifers fed additional vitamin E or vitamin E and fat combined (-4.16 vs –.99 & -.65 ± .88; P<.01), respectively. When comparing heifers fed additional vitamin E with those fed additional vitamin E and fat (-.99 vs –.65 ± .88), no differences were observed for change in E concentration (P=.69). The results of vitamin E and cholesterol concentrations charted over time are presented in Figures 1 and 2, respectively. The results of vitamin E concentration presented in Figure 1 show a response of serum vitamin E levels to added vitamin E in the diet. The addition of vitamin E to the fat supplemented heifers resulted in less overall change in cholesterol concentration compared with control heifers and those supplemented with vitamin E alone (.12 vs – .66 & -.46 ± .21; P=.05), although overall cholesterol concentrations were only slightly affected by treatment.

Figure 1. Serum [vitamin E] measured by dietary treatment at four time intervals

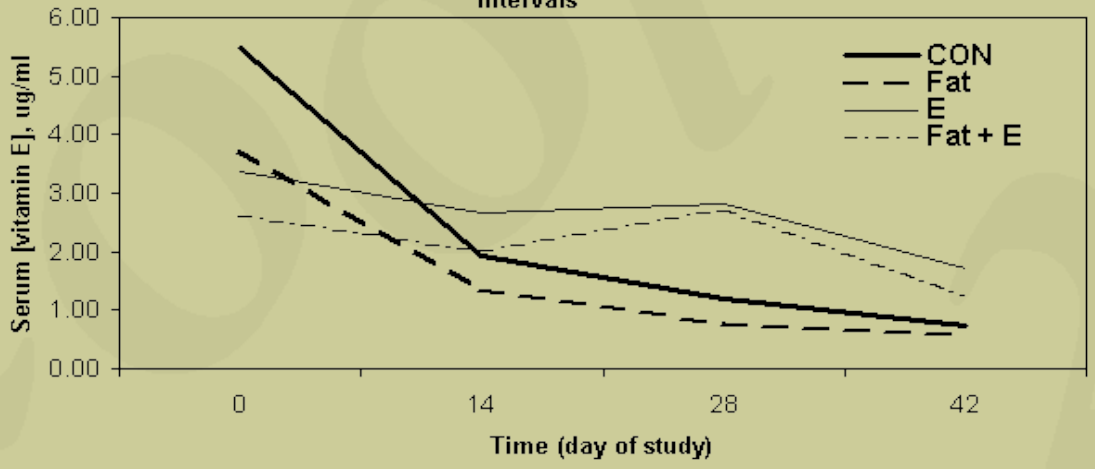
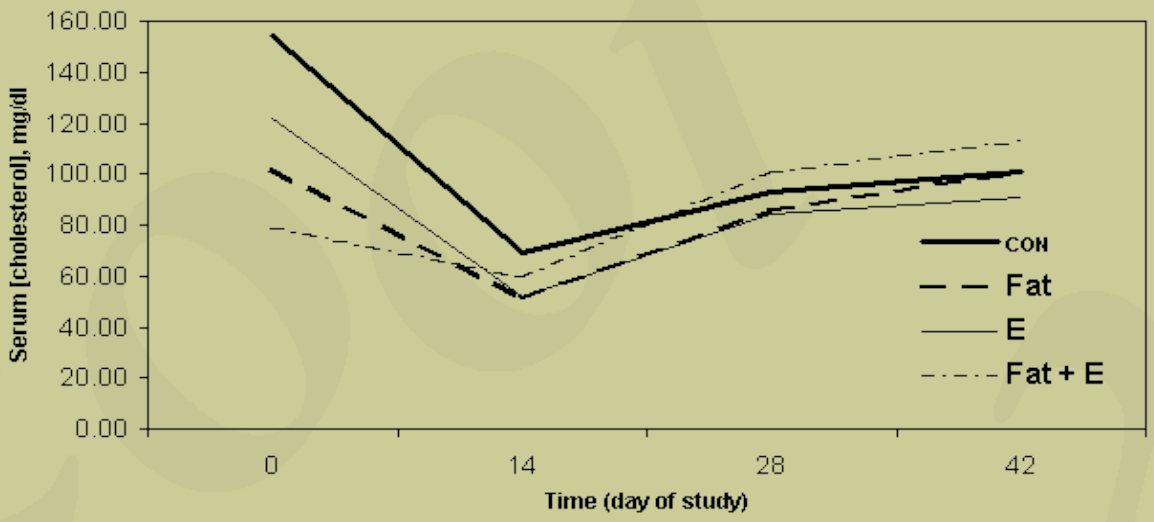


Figure 2. Serum [cholesterol] measured by dietary treatment at four time intervals



Implications

The addition of vitamin E to the receiving diet increased serum levels of vitamin E in this experiment. There is little evidence to suggest that additional fat aided in the absorption or transport of vitamin E, or that fat caused a greater utilization of vitamin E over time. Additional experiments are warranted in order to examine the degree of feed fat oxidation and its effect on systemic antioxidants.

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