Dietary vitamin E inhibits the trans 10-18:1 shift in beef backfat

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Juárez, M., Dugan, M. E. R., Aalhus, J. L., Aldai, N., Basarab, J. A., Baron, V. S. and McAllister, T. A. 2010. Dietary vitamin E inhibits the trans 10-18:1 shift in beef backfat. Can. J. Anim. Sci. 90:9-12. Forty feedlot steers were fed a barley-grain-based finishing diet typical for western Canada, with two levels of supplementary vitamin E (468 or 1068 IU head⁻¹ d⁻¹) and the effect on backfat trans-18:1 isomeric profile was determined. Feeding 1068 IU vitamin E reduced the total trans-18:1 content in backfat (P<0.01), as well as the percentage of trans-10-18:1 (P<0.001), which are related to an increased risk for cardiovascular diseases. On the other hand, trans-11-18:1 (vaccenic acid) the precursor for cis 9,trans 11-18:2 (rumenic acid), which have several purported health benefits, increased (P<0.01). Vitamin E could, therefore, be used to decrease trans-18:1 in beef and improve its isomeric profile.

Key words: Beef, trans fatty acid, vaccenic acid, vitamin E

Vitamin E, due to its effects on nutritional myopathy, retinal degeneration, erythrocyte hemolysis and prostaglandin biosynthesis, is an essential nutrient for the growth and health of beef cattle (Machlin 1985; McDowell et al. 1996). Furthermore, vitamin E is widely used as an antioxidant in biological systems, and its accumulation in muscle has been shown to have a positive impact on colour and lipid stability of fresh and frozen beef (Liu et al. 1995). Recent results also suggest that dietary vitamin E can prevent the “trans 11 to trans 10-18:1 shift” in milk and plasma of dairy cattle (Kay et al. 2005; Pottier et al. 2006). High levels of barley, typically used in finisher diets in western Canada, produce a rumen environment conducive to biohydrogenation of polyunsaturated fatty acids (PUFA) through the trans 10-18:1 pathway resulting in an increased rate of its deposition (Dugan et al. 2008). In fact, trans 10-18:1 has been shown to be the major trans 18:1 isomer in Canadian retail beef (Aldai et al. 2009). Cardiovascular health risks in humans and animal models (Hodgson et al. 1996; Bauchart et al. 2007; Roy et al. 2007) have been associated with trans 10-18:1. Therefore, development of strategies to decrease trans 10-18:1 levels in beef would be positive for cardiovascular health.

Abbreviations: PUFA, polyunsaturated fatty acids

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both consumers and producers. On the other hand, trans 11-18:1 (vaccenic acid) could have beneficial effects on human health by itself (Tholstrup et al. 2006) and by its conversion to cis 9,trans 11-18:2 (CLA, rumenic acid), which has been shown to provide protection against cancer, diabetes and inflammatory diseases in both animal and cell models (Belury 2002; Ip et al. 2003). The present study was undertaken to elucidate the effect of dietary vitamin E on the detailed trans-18:1 profile of backfat from beef cattle fed a typical western Canadian finisher diet high in ground barley.

Animal Management

Animals were raised and slaughtered in accordance with the principals and guidelines established by the Canadian Council on Animal Care (1993). Forty feedlot steers were housed in four feedlot pens (two pens per dietary treatment, 10 animals per pen, n = 20 animals per dietary treatment) and fed ad libitum diets consisting of 72.8% steam-rolled barley, 22% alfalfa/brome hay, 2.73% feedlot (32% CP) supplement, 1.73% oil and contained 22 mg kg⁻¹ vitamin/mineral premix, 0.39% molasses, 0.39% canola meal, 0.430% l-threonine, 0.430% L-lysine HCl, 0.430% monensin (as-fed basis; 86.4% dry matter). The basal diet contained 17,14, 11, 8, 5, 2, 10, 19, 5, 11, 13/14 and 16-18:1 and 11-18:1 (Figs. 1 and 2). Among trans isomers, the reduction of trans 10-18:1 (−46%) and the increase of trans 11-18:1 (+28%) in the high vitamin E group were of the greatest magnitude. The prevention of the “trans 11- to trans 10-18:1 shift” was previously observed in plasma (Kay et al. 2005) and milk (Pottier et al. 2006) when feeding supplementary vitamin E, even when high levels of PUFA were included in the diet. These results indicate that vitamin E can influence ruminal pathways of PUFA biohydrogenation although the mechanism has not been firmly established. Differences in the rumen environment, primarily affected by diet, can influence rumen microbial population (Klieve et al. 2003). Furthermore, Pottier et al. (2006) hypothesized that vitamin E could also act either as an inhibitor of bacteria producing trans 10-18:1 or as an electron acceptor for Butyrivibrio fibrisolvens, a species mainly present in the rumen.

Results and Discussion

Feeding 1068 IU vitamin E to cattle on a high-barley finisher diet reduced total trans-18:1 in backfat by 27% compared with the control diet (3.85 ± 0.439 vs. 2.81 ± 0.430, respectively; P < 0.01). As previously observed by other authors in high-concentrate-fed beef cattle, trans 10-18:1 was the major trans-18:1 isomer, followed by trans 11-18:1 (Dugan et al. 2007; Aldai et al. 2008). The increase in dietary vitamin E resulted in increases (P < 0.05) in trans 4, 5, 11, 13/14 and 16-18:1 and decreases (P < 0.01) in trans 6/7/8 and 10-18:1 (Figs. 1 and 2).

Carcass Measurements and Sampling

Animals were slaughtered over five slaughter dates (four animals per dietary treatment per slaughter day) at a target ultrasound backfat measurement of 8–9 mm. At 24 h, the left loin was dissected from the carcass and a sample of backfat was collected and stored at −80°C for further fatty acid analysis.

Fatty Acid Analysis

Backfat samples (50 mg) were freeze-dried and directly methylated with sodium methoxide. The trans-18:1 isomers were analyzed using two complementary GLC temperature programs (Dugan et al. 2007; Kramer et al. 2008) and their contents were expressed as percentage of total trans-18:1 isomers.

Statistical Analysis

Statistical analysis of fatty acids were performed using the PROC MIXED procedure of SAS software (SAS Institute, Inc. 2003), and, initially, vitamin E treatment was included as the main effect, pen as a random effect and slaughter date as a blocking factor. A pen effect was not found for any fatty acid studied and, therefore, it was removed from the statistical model, leaving individual animal as experimental unit according to procedures described by Gill et al. (2008). The LSMEANS and PDIFF options were used for generating least squares means and comparison of treatments by F-test.

![Fig. 1. Effect of high dietary vitamin E on trans-18:1 isomeric profile (% of total trans 18:1 fatty acids) of backfat from steers fed a high barley finisher diet.](image-url)
related to fibre digestion (i.e., pasture-based feeding). This may be due to \( \alpha \)-tocopherol’s structural similarity to other compounds (e.g., \( \alpha \)-tocopherolquinol and deoxy-\( \alpha \)-tocopherolquinol) involved in the biohydrogenation of cis 9,trans 11-18:2 to trans 11-18:1 (Hughes and Tove 1980a,b). On the other hand, environmental stress has been shown to be an important factor for bacterial production of trans fatty acids (Härtig et al. 2005). Therefore, an alternative hypothesis could be that vitamin E alleviates oxidative stress resultant from changes in ruminal conditions resulting in lower production rates of trans fatty acids.

In conclusion, based on previous studies on plasma and milk and present findings in meat, vitamin E may be useful as a simple and effective way to decrease trans-18:1 in beef and improve its isomeric profile when feeding high-concentrate diets. Its effective level and interaction with diets high in PUFA, therefore, warrant further investigation as a means to increase tissue levels of beneficial biohydrogenation products (i.e.,trans 11-18:1 and cis 9,trans 11-18:2), which have many known health benefits.

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containing corn or sorghum distillers grains on beef color, fatty acid profiles, and sensory attributes. J. Anim. Sci. 86: 923–935.