SHORT COMMUNICATION

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

Juárez, M., Dugan, M. E. R., Aalhus, J. L., Aldai, N., Basarab, J. A., Baron, V. S. et McAllister, T. A. 2010. **Le vitamine E des aliments entrave la conversion des acides gras *trans* 10-18:1 dans le gras dorsal des bovins**. Can. J. Anim. Sci. **90**: 9–12. Quarante bouvillons d'engrais ont reçu une ration de finition à base d'orge typique à celle employée dans l'ouest du Canada, mais enrichie de vitamine E à deux concentrations (468 ou 1 068 UI par tête, quotidiennement), avant établissement du profil isomérique des acides gras *trans*-18:1 pour le gras dorsal. La dose de 1 068 UI de vitamine E diminue la concentration totale d'acides gras *trans*-18:1 dans le gras dorsal ($P < 0{,}01$), ainsi que la proportion des acides gras *trans* 10-18:1 ($P < 0{,}001$) associés à un risque plus élevé de maladies cardiovasculaires. Parallèlement, on note une hausse ($P < 0{,}01$) de la concentration de l'acide gras *trans* 11-18:1 (acide vaccénique), précurseur de l'acide gras *cis* 9,*trans* 11-18:2 (acine ruménique), qu'on présume avoir plusieurs effets bénéfiques sur la santé. Par conséquent, on pourrait se servir de la vitamine E pour réduire la concentration d'acides gras *trans*-18:1 dans le bœuf et rehausser le profil isomérique de cette viande.

Mots clés: Bœuf, acides gras *trans*, acide vaccénique, 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

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Abbreviations: **PUFA**, polyunsaturated fatty acids

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% vitamin/mineral premix, 0.39% molasses, 0.39% canola oil and contained 22 mg kg^{-1} monensin (as-fed basis; 86.4% dry matter). The combined feedlot supplement and vitamin/mineral premix contained (% basis) Ca, 8.63, P, 2.10, Na, 1.25, K, 0.65, Mg, 0.20, S, 0.24 (on a mg kg^{-1} basis) Mn, 2186, Zn, 2788, Fe, 948, Cu, 903, Co, 17, I, 48, Se, 14 (on an IU basis) vitamin A, 240 200, vitamin D, 44 930, vitamin E, 910. The finishing diet was fed over a 90-d period and animals were not treated with any growth implants. Dietary treatments consisted of Control (39 IU dl-α-tocopheryl acetate per kilogram of basal diet (as fed) providing 468 IU per animal per day) and vitamin E (468 IU vitamin E from the basal diet with 600 IU dl-α-tocopheryl acetate of vitamin E top dressed per animal feed allocation per day providing a total 1068 IU per animal per day).

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.

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). 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

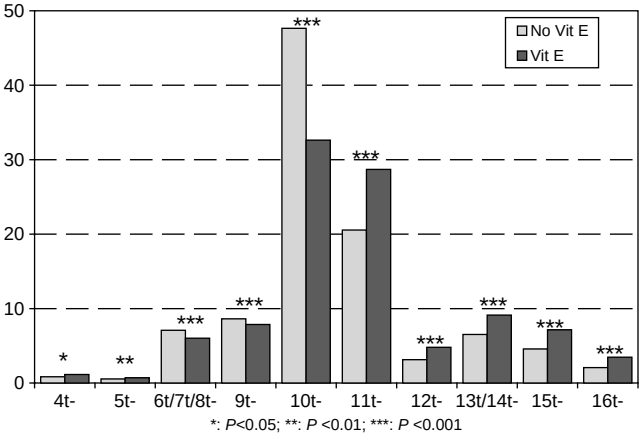

Fig. 1. Effect of high dietary vitamin E on *trans*-18:1 isomeric profile (% of total *trans* 18:1 fatty acids) of backfat from steers fed a high barley finisher diet.

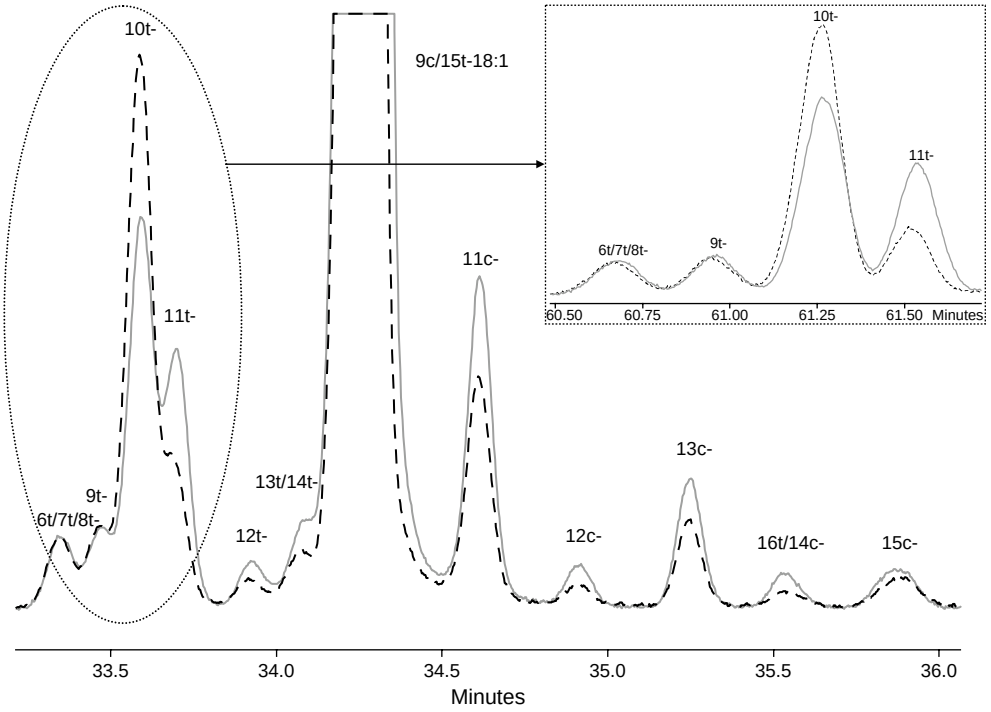

Fig. 2. Representative *trans*-18:1 region partial GLC chromatograms of backfat using 175°C (main) and 150°C (zoom) temperature programs (Control: dotted line; High vitamin E: solid line).

related to fibre digestion (i.e., pasture-based feeding). This may be due to α-tocopherol's structural similarity to other compounds (e.g., α-tocopherolquinol and deoxy-α-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 (Haïrtig et al. 2005). Therefore, an alternative hypothesis could be that vitamin E alleviates oxidative stress on bacteria 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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