Milk enriched in omega-3 fatty acids: the challenges associated to its preservation

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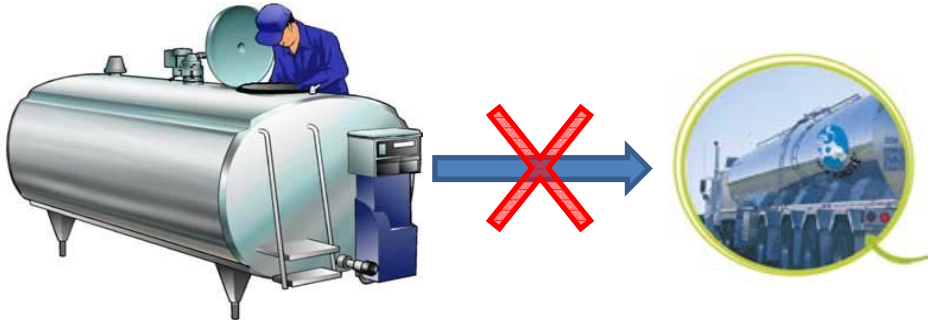
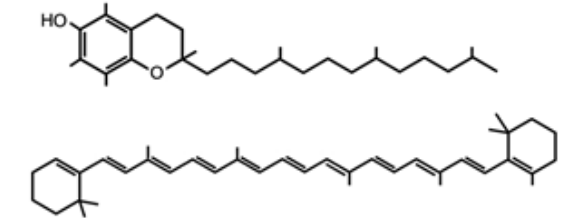
Enriching milk with ω-3 fatty acids (FA)

To be labeled as source of ω-3 in Canada → **300 mg/portion**

- In a glass of milk (250 mL) at 2% fat = **6% of milk FA**
- Average glass of milk **≈ 0,5% 18:3 ω-3 (α-linolenic acid; ALA)**

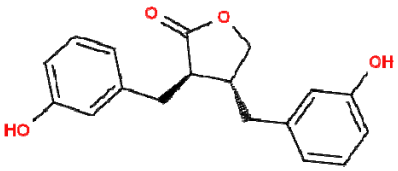


Unusual odors (e.g. aldehydes) in high PUFA milk are cause for rejection at pick up



Vitamin E

β-carotene



Enterolactone

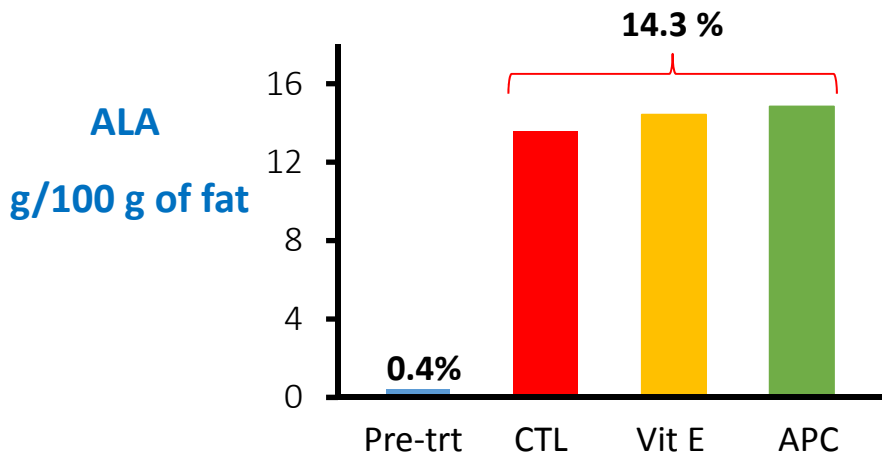
Feed antioxidants could be transferred into milk and prevent oxidation

Objectives

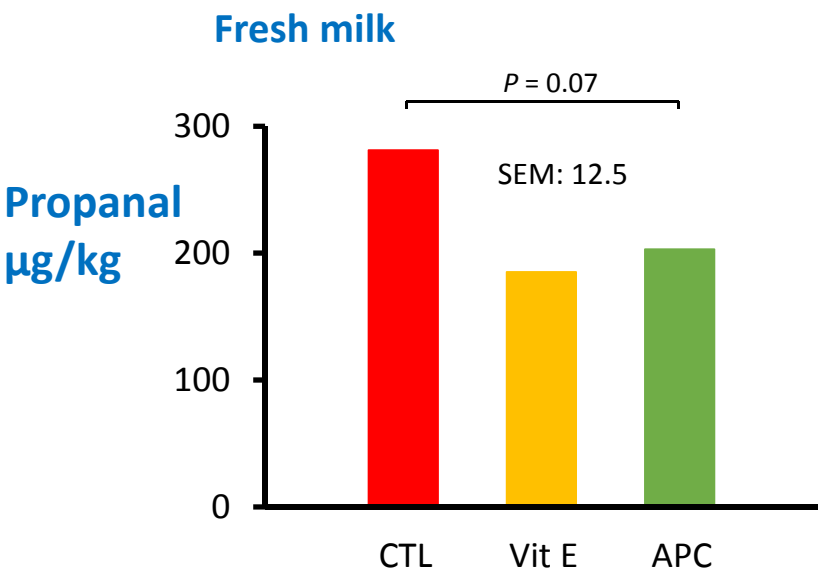
- To investigate the effects of feed antioxidants such as vitamin E, carotenoids (from an alfalfa protein concentrate; APC), and lignans (from linseed meal; LM) on oxidative stability of high ω-3 FA milk

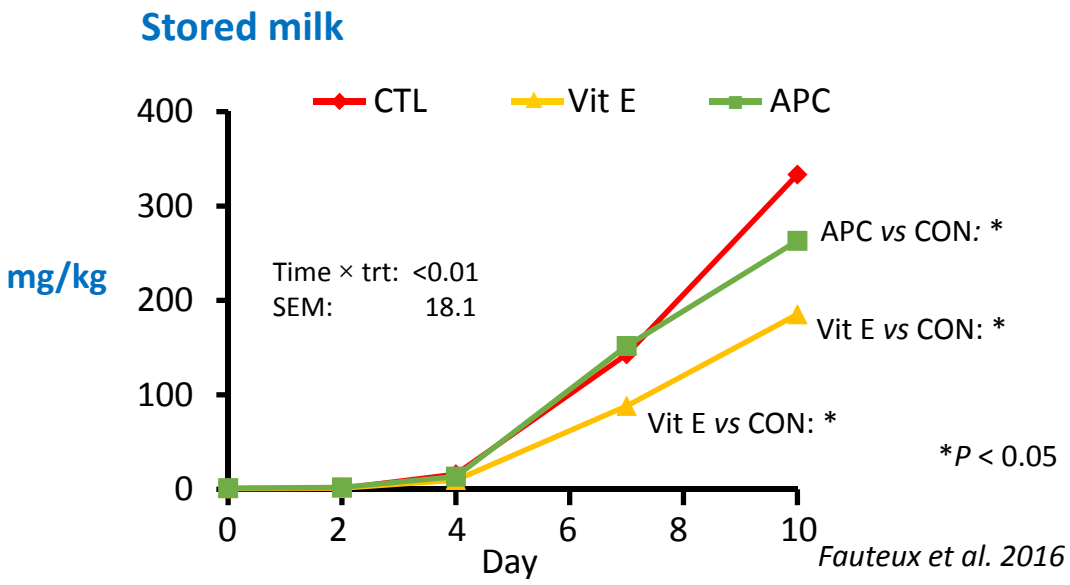
- To evaluate the oxidative stability of fresh and stored milk enriched in ω-3 FA by increasing doses of abomasally infused linseed oil

Carotenoids from an alfalfa protein concentrate



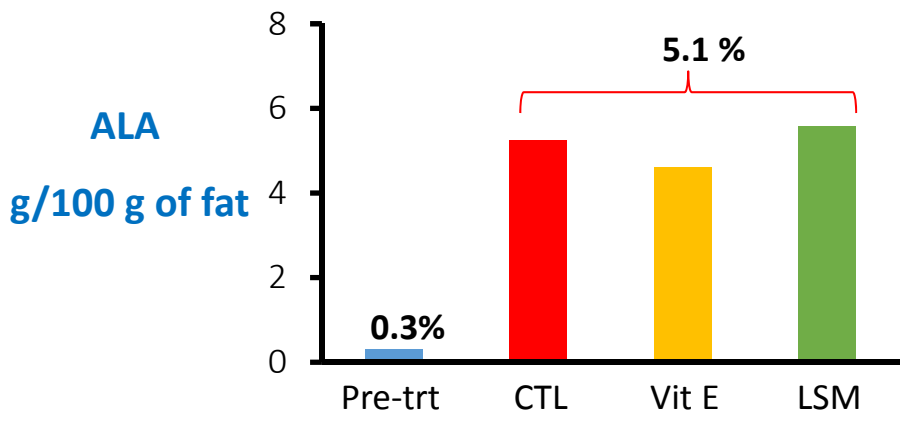
- 6 multiparous Holstein cows (224 ± 18 DIM, 22,0 ± 3,2 kg milk/d)
- 3x3 Latin square design with 21d periods
- APC at 9 % of ration DM, replacing soybean meal.
- 450 g/d abomasal infusion of linseed oil



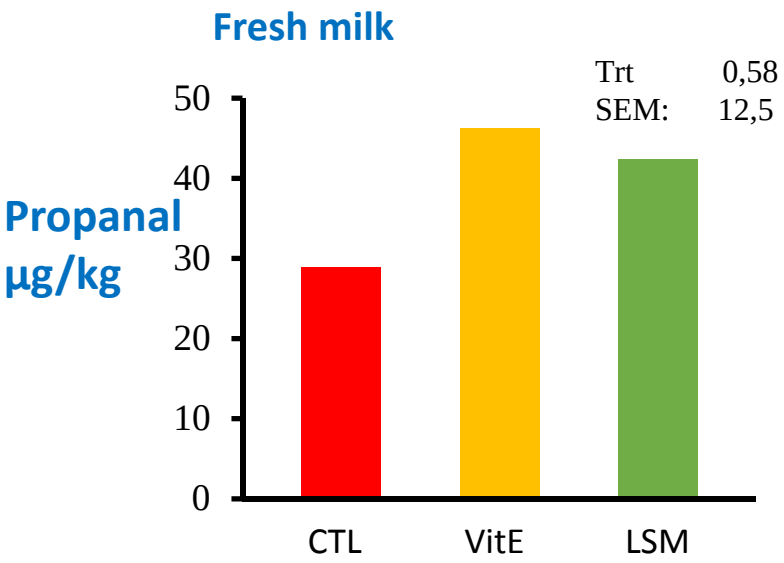


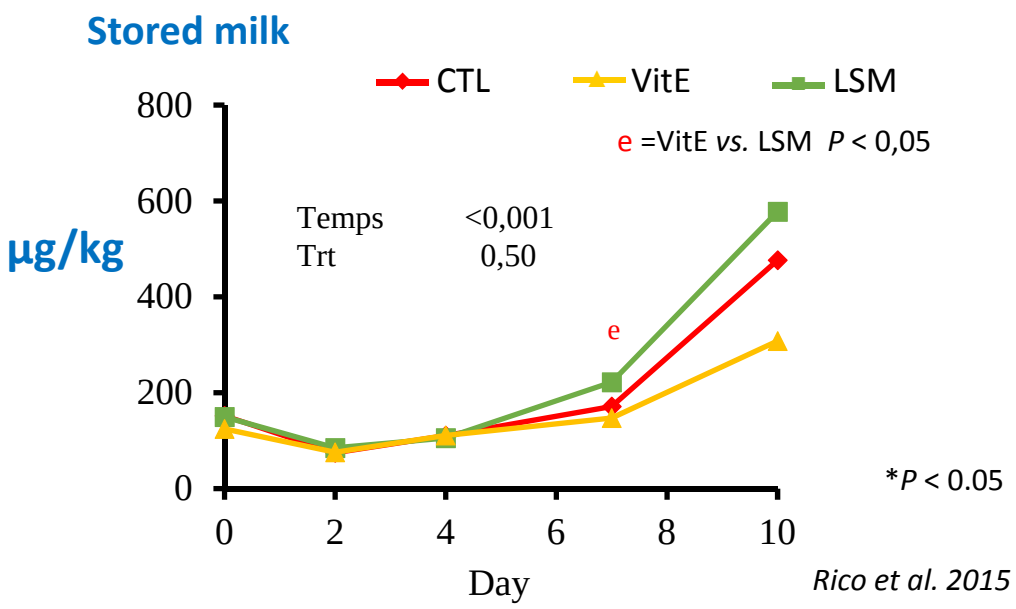
Fauteux et al. 2016

Lignans in linseed meal as milk antioxydants



- 6 multiparous Holstein cows (120 ± 30 DIM, 36,3 ± 6,5 kg milk/d)
- 3x3 Latin square design with 21d periods
- LSM at 16 % of ration DM, replacing canola meal.
- 243 g/d abomasal infusion of linseed oil



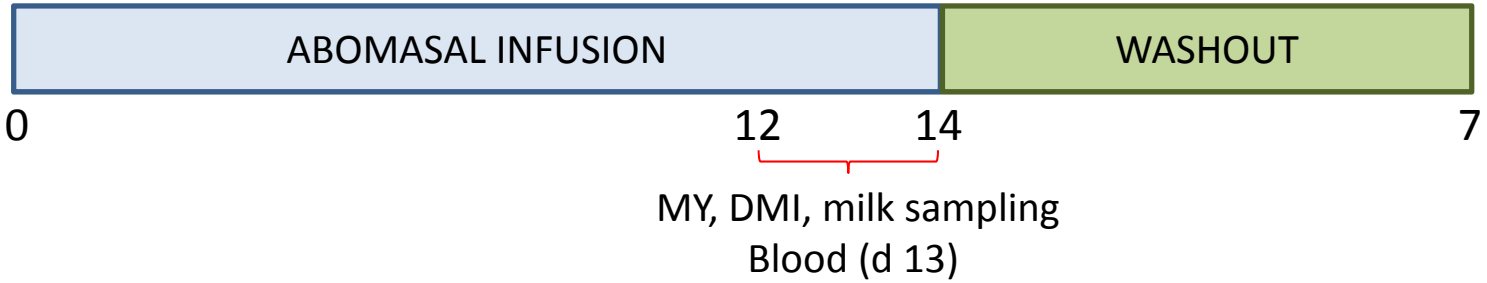


Rico et al. 2015

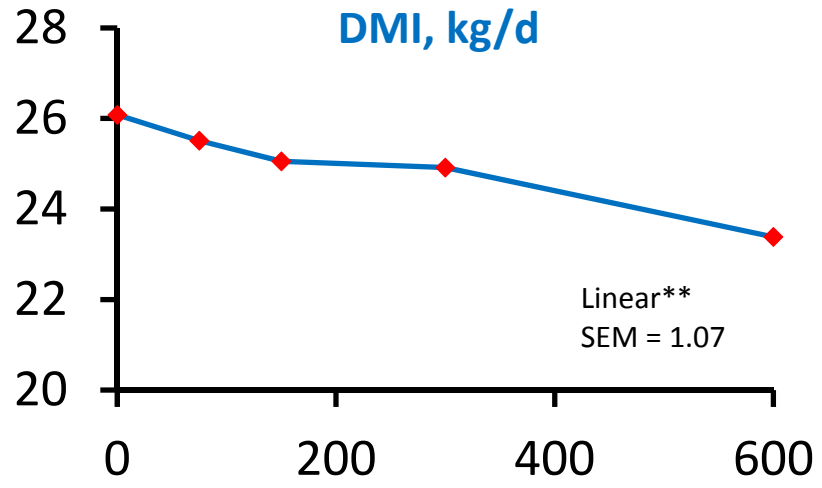
Effects of increasing doses of linseed oil on milk peroxydability

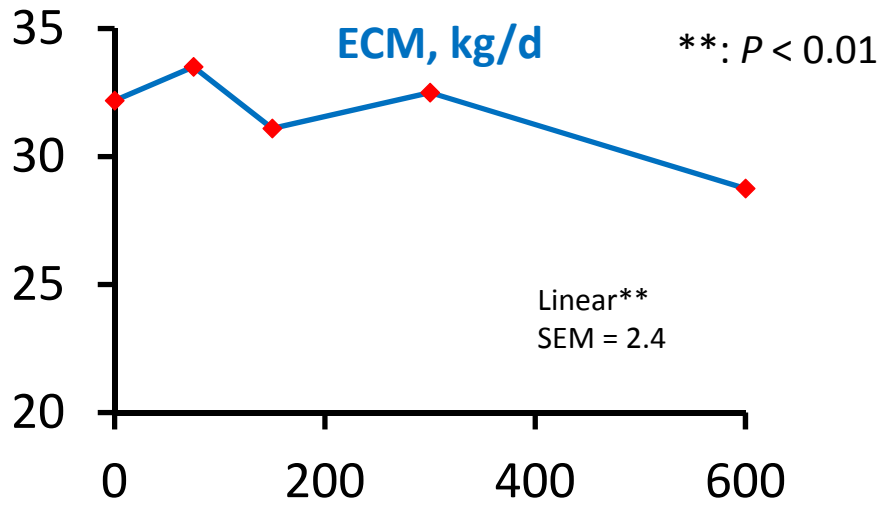
- 5 rumen-fistulated Holstein dairy cows (36 ± 2 DIM; 39 ± 5 kg milk/d) in Latin square design
- Continuous abomasal infusion of linseed oil (53% ALA):

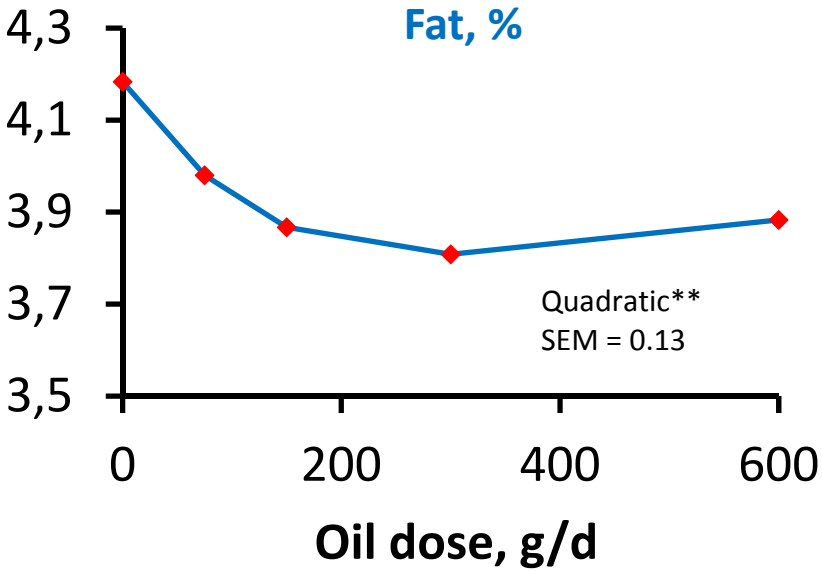
0, 75, 150, 300, or 600 g/d

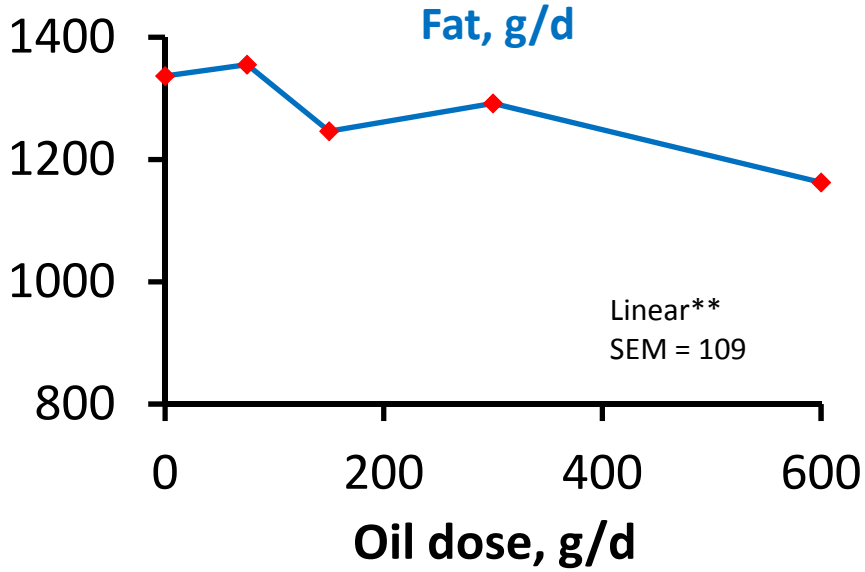


DMI, ECM and milk fat decreased with linseed oil dose



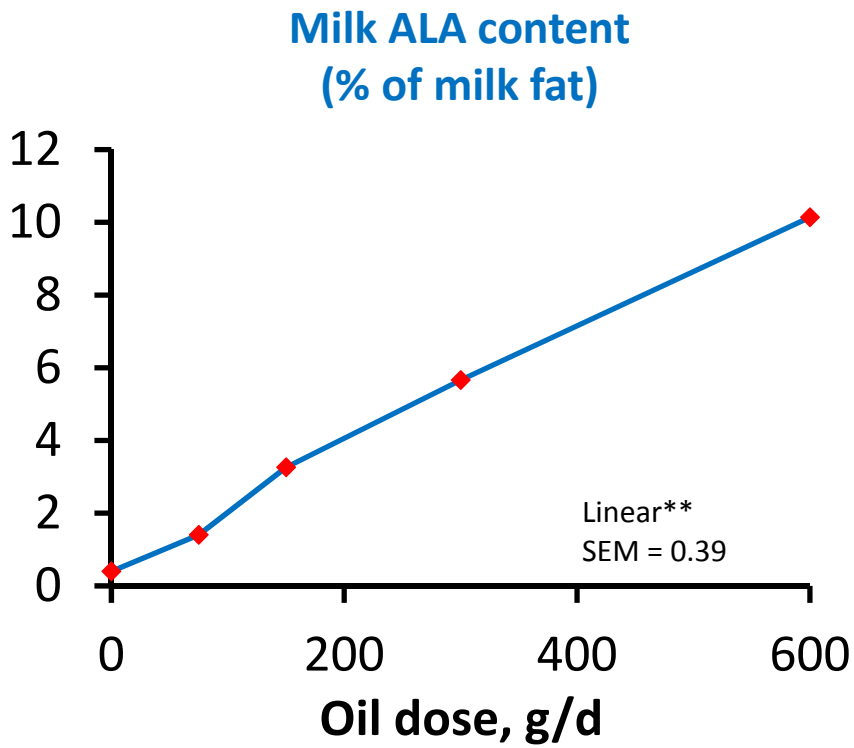


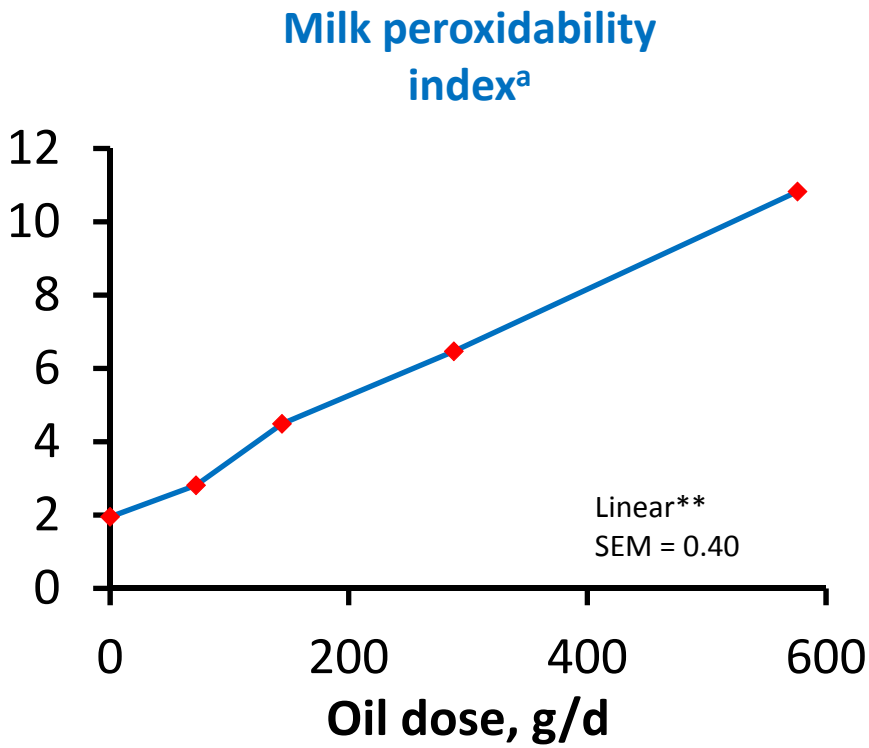




Milk ALA content and peroxidability index increased linearly with linseed oil dose

**: $P < 0.01$





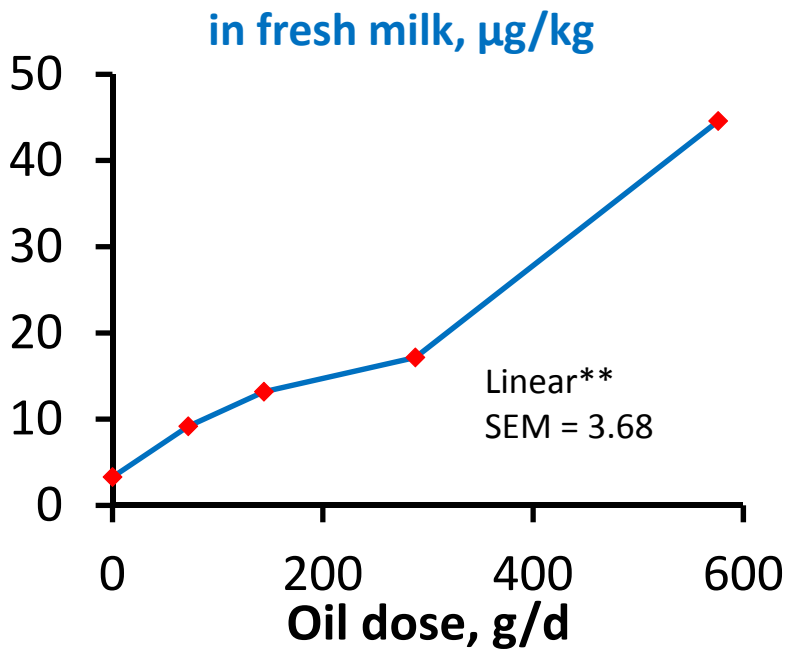
Milk FA analyses by GC
(Boivin et al., 2013)

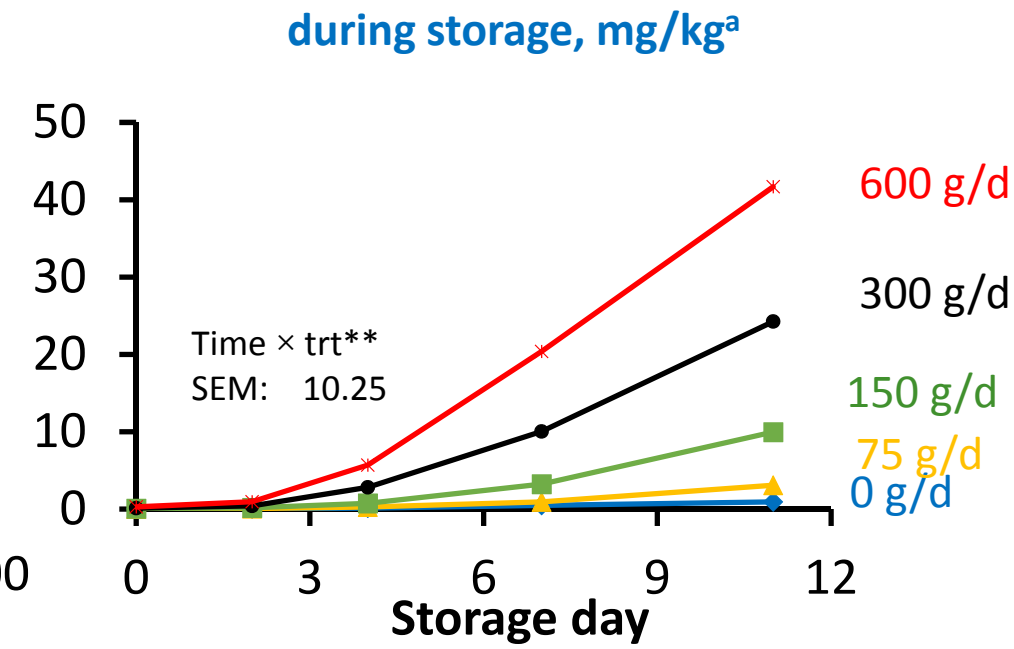
[a]Calculated as mg/g milk: 0.025×Mono + 1×Di + 2×Tri + 4×Tetra + 6×Penta + 8×Hexa
(Witting and Horwitt, 1964)

Volatile oxidation products (GC-MS) increased linearly with linseed oil dose

**: $P < 0.01$

Propanal





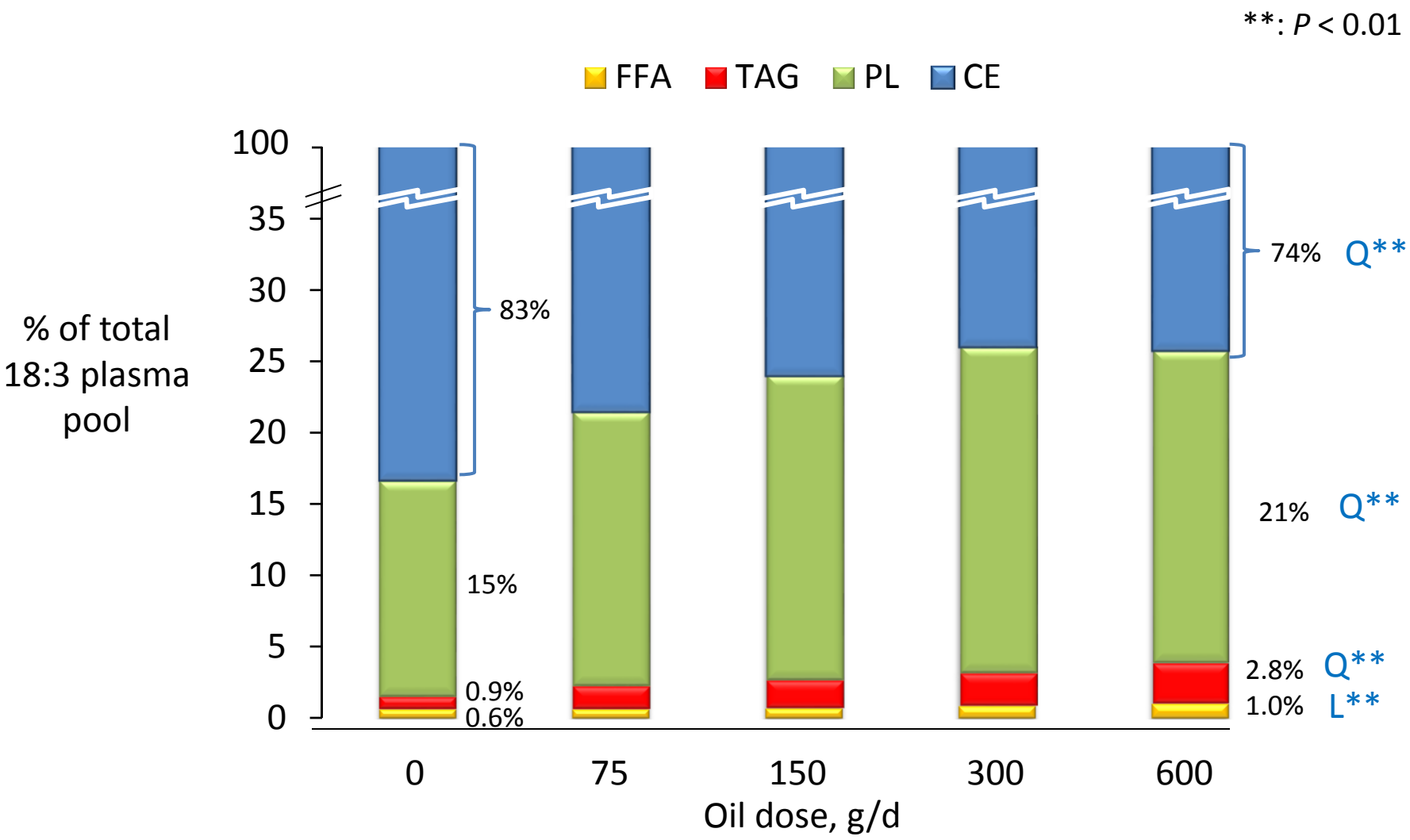
Similar pattern observed for other volatile compounds:

Hexanal,
*t*2-hexenal/hex-*c*3-enal,
hept-*c*4-enal,

1-octen-3-one,
*t*2*c*6-nonadienal
*t*2*t*4-nonadienal

[a]Under fluorescent light at 4 °C

ALA increased in all plasma lipid fractions



Conclusions

- Some plant antioxidants (Carotenoids from APC) have the potential to prevent spontaneous oxidation of high ω-3 milk.

- Abomasal infusions of linseed oil negatively affected animal performance
- Oxidative stability of fresh and stored milk decreased with increasing dose of linseed oil
- Cholesterol esters where highly enriched in ALA regardless of dose

Thank you!

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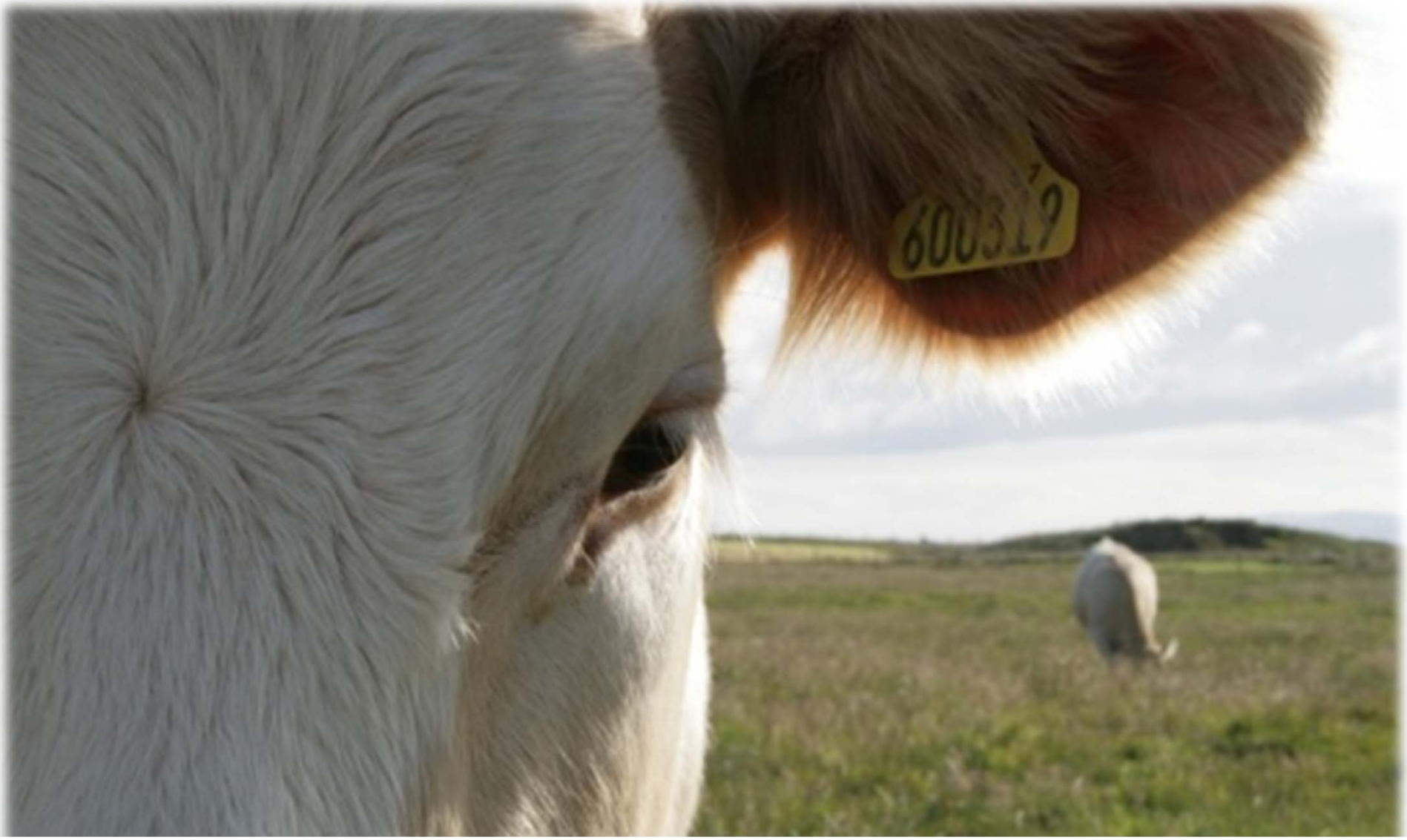
Dairy Farmers of Canada

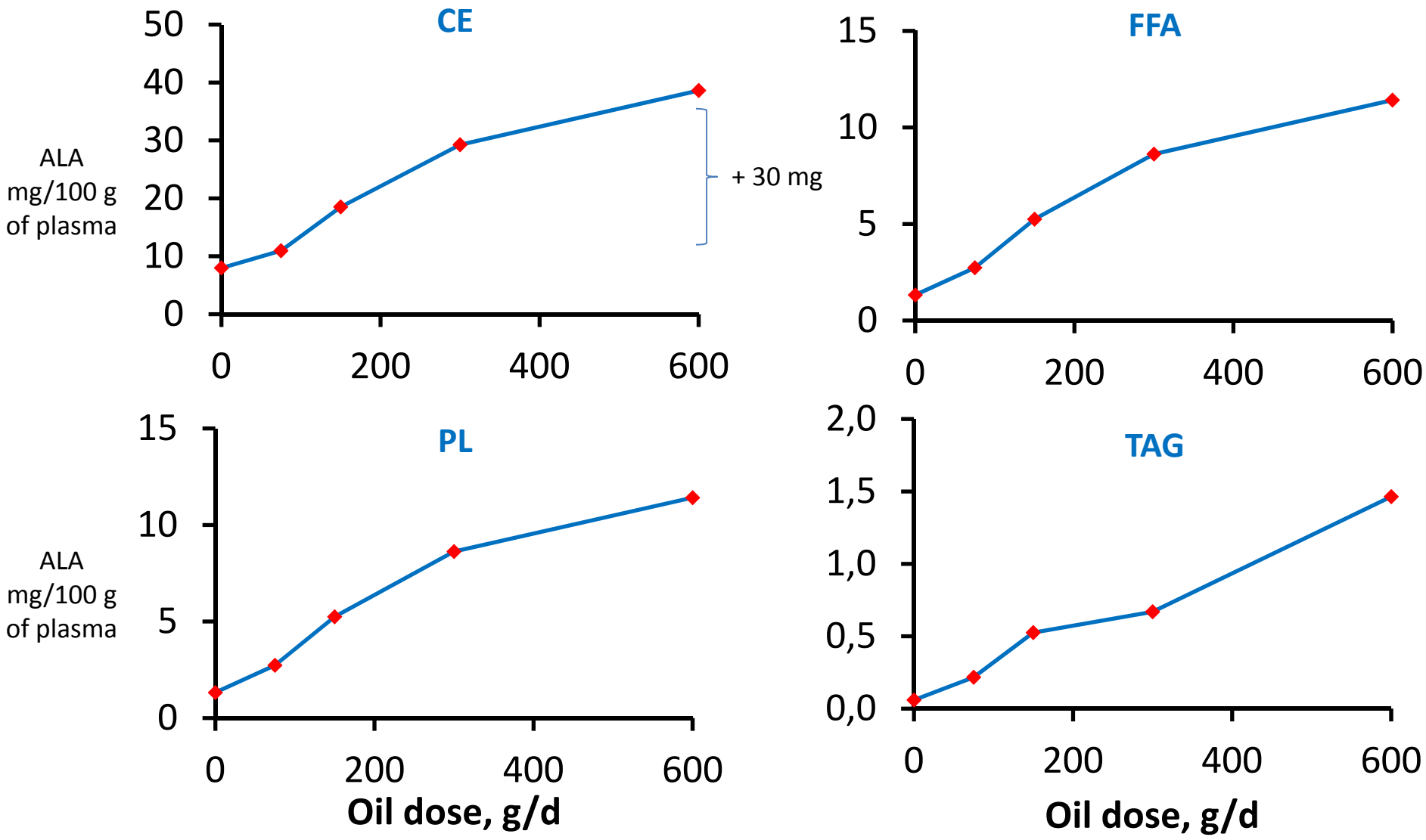
Les Producteurs laitiers du Canada

Les Producteurs de lait du Québec

Questions



ALA is preferentially incorporated into CE



18:3 ω-3 increased with linseed oil dose in all plasma lipid fractions