

Effects of duration and temperature of heating of sunflower oil on ruminal linoleic acid biohydrogenation in vitro

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Conjugated linoleic acids would be benefit for human health. The major source of CLA in human food is dairy products. One way to increase CLA in cow milk is to add oilseeds in their diet, and the best results are obtained with heat treated oilseeds (Chouinard et al. 2001*). Heating leads to a lipid peroxidation, which could reduce the amount of fatty acids subjected to biohydrogenation and produce peroxides which could act directly on this reaction. This study investigated the effects of the two main modulators of fat peroxidation, heating duration (experiment 1) and temperature (experiment 2), on the biohydrogenation in ruminal cultures.

MATERIAL & MATHODS

- Preparation of oxidized oil: sunflower oil was heated at 150°C during 0, 3, 14, or 22 hours, or during 3 hours at 70, 100, 130, or 160°C (Table 1).
- In vitro: Oils were incubated with buffered ruminal contents and a fermentation substrate in a rotary bath during 6 hours, at 39°C, without oxygen and in darkness. Inc ubated samples were frozen and lyophilised.
- Analysis of fatty acids: samples and oils were analysed by gas chromatography after methylation (Park and Goin, 1994) and addition of an internal standard (C19:0).
- Analysis of peroxides: The degree of peroxidation was determined by the peroxide index (PI).
- Statistic: Linear relationships (SYSTAT, version 9, SPSS Inc., USA) were researched between C18:2, total CLA, C18:2c9t11, C18:2t10c12, total *trans*-C18:1, C18:1t10, C18:1t11 and C18:0 (% of total fatty acids), and the temperature (°C) or the duration (h) of heating. Mo reover linear relationships were also researched between final total fatty acids content (mg/kg DM) or c9t11-CLA (% of total fatty acids) and IP (mEq/kg DM), across the two experiments.

RESULTS & DISCUSSION

- Increasing heating duration was more efficient than increasing heating temperature for peroxides production: **Table 1**.
- The percents of cis9,trans11-CLA (C18:2c9t11) and trans-vaccenic acid (C18:1t11) decreased with the heating duration: **Figure 1**.
- The percent of C18:2c9t11 decreased with the heating temperature: **Figure 2**, but this relationship was lower than for heating duration, and there was no effect of temperature on C18:1t11 percent, possibly because high heating temperature generated less peroxides than long heating duration.
- Across the two studied parameters, the percent of C18:2c9t11 decreased when oil IP increased (-0.35% / mEq of PI/kg): **Figure 3**
- Final FA content decreased when oil IP increased (-0.11% / mEq of PI/kg): **Figure 4**, suggested that the effect was mainly due to the peroxides, not only to the decrease of FA content.

heating temperature (°C)	150				70	100	130	160
heating duration (h)	0	3	14	22	3			
oil IP (mEq / kg)	15.9	41.9	93.0	162.8	40.9	35.9	84.0	88.2

Table 1: peroxide index of heating oil

CONCLUSIONS

- Increasing temperature and mainly heating duration of oil led to a decrease of C18:2c9t11 production in the rumen.
- Increasing heating duration also decreased C18:1t11 production.
- Peroxides formation could be incriminated indirectly by a decrease of unsaturated fatty acids available for biohydrogenation but also probably directly by an action on enzymes for example.
- Peroxides cannot explain the increase of milk CLA noticed in the milk from cows eating heated oilseeds
- A good quality of fat, without lipids oxidation products, is necessary to increase CLA and C18:1t11 production in the rumen.

* Chouinard, P. Y., L. Corneau, W. R. Butler, Y. Chilliard, J. K. Drackley, et D. E. Bauman. 2001. Effect of dietary lipid source on conjugated linoleic acid concentrations in milk fat. *J. Dairy Sci.* 84 : 680 – 690.

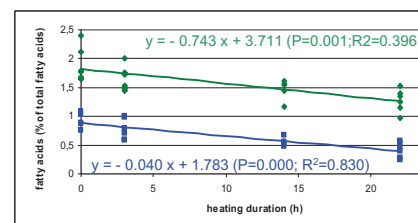


Figure 1: Effect of heating duration on the percents of C18:2c9t11 (■) and C18:1t11 (◆)

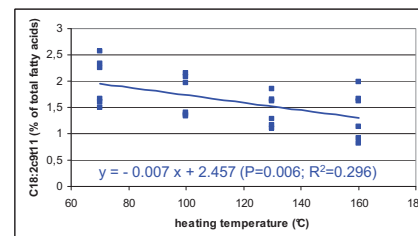


Figure 2: Effect of heating temperature on the percent of C18:2c9t11 (■)

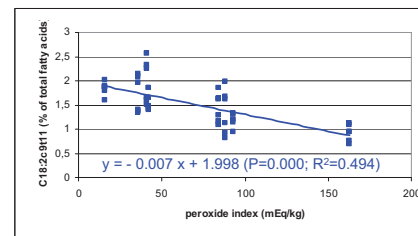


Figure 3: Effect of increasing peroxide index on the percent of C18:2c9t11 (■)

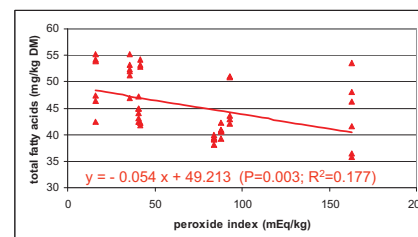


Figure 4: Effect of increasing peroxide index on the final total fatty acids content (▲)