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The effect of chilled storage (up to 12 weeks) on Australian beef health claimable fatty acid content (#253)

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Introduction

Considerable effort has been made to optimise the nutritional value of beef – specifically, production and processing methods to enhance its content of the health claimable eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). This is because consumers will consider beef's nutritional value and reputation for healthiness when choosing to purchase.

The distribution of Australian beef export markets requires long term chilled storage periods so as to smooth production gluts, provide supply consistence and attract premium market share. This is characteristic of other beef exporting nations. EPA and DHA are both long chain polyunsaturated fatty acids (PUFA). Therefore, these health claimable fatty acids (FA) have greater susceptible to autoxidation, at cooler temperatures comparative to other FA with *stronger* C-H bonds and more resistance to the actions of free radicals [1]. Based on this knowledge it was apparent that the status of beef EPA and DHA contents merits investigation when it is held chilled for up to 12 weeks and therefore prone to oxidation.

Methods

Eight striploins (*M. longissimus lumborum*) were selected at random from the boning room of an Australian abattoir. These were each divided into five equal portions that were vacuum-packaged and assigned to a chilled storage period (0, 5, 8, 10 or 12 weeks). The chiller temperature profile was 1.5 ± 0.8 °C (mean ± standard deviation). Samples were tested at the completion of their chilled storage period.

Samples were first freeze-dried and ground. 0.5 g subsamples were removed and their lipid components isolated in 10 mL $CHCl_3$:CH_3OH (2:1 v/v). FA profiles were determined using 200 µL aliquots of these total lipid extracts evaporated under nitrogen gas within individual glass tubes. Added to each tube was 2 mL of CH_3OH:toluene (4:1 v/v) that contained C19:0 and C13:0 as an internal standard (0.02 mg/mL). These were then vortexed with 200 µL acetyl chloride and heated to 100 °C for 1 h so as to permit methylation. Samples were cooled and methylation halted with the addition of 5 mL of 6% K_2CO_3. These were again vortexed, and then centrifuged to facilitate the separation of the layers. The upper toluene layers were then transferred into glass GC vials for analysis [2].

Individual fatty acid methyl esters (FAME) were measured using an Agilent 6890 N GC fitted with a flame ionisation detector (FID). FAME were separated using a fused C-SiO_2 column with cyanopropylphenyl coating (BPX70, 30m x 0.25 mm i.d. and 0.25 µm film thickness). Helium was used as the carrier gas, having 12.4 mL/min total flow rate, a split ratio of 10:1, and a column flow of 0.9 mL/min. Inlet pressure was set to 107.8 kPa, its temperature to 250 °C, and injection volume to 3 µL into a focused inlet liner (4 mm i.d.). Oven temperature was set to 150 °C and held for 30 s; increased at 10 °C/min to 180 °C; increased at 1.5 °C/min to 220 °C; and then increased at 30 °C/min up to 260 °C where this was maintained for 5 min so as to result in a 36.5 min total run time. FID temperature was 280 °C with H_2 flow rates of 35 mL/min, instrument air of 350 mL/min, and N_2 make-up gas of 30 mL/min. Sample FAME peaks were identified with reference to the internal standards. FA data were expressed as mg/100g fresh weight.

Data were analysed using analysis of variance models fitted with chilled storage period as the fixed effect; striploin as a block (random) effect; and intramuscular fat content as the covariate. The inclusion of IMF data in this analysis was based on its previously found significant variation across the chilled storage periods. Differences between predicted means were significant if $P < 0.05$.

Results

Figure 1 shows that the total health claimable FA content of beef samples did not vary across the chilled storage periods ($P = 0.609$), this with no intramuscular fat content covariate effect evident ($P = 0.519$). The predicted mean ± standard error of the total health claimable FA content across all chilled storage periods was 14.5 ± 0.6 mg/100g adjusted for IMF. It should be noted that is level is lower than otherwise expected. This summative result reflects the absence of any individual variation to EPA ($P = 0.849$) or DHA ($P = 0.336$) across the same chilled storage periods.

Conclusion

These results suggest that beef produced to be *healthier*, based on the EPA and DHA content, will remain so, for up to 12 weeks. That said – this is a conditional conclusion. For example, if the experimental beef samples had lesser antioxidant potentials, higher initial content of PUFA (including EPA and DHA), or were held under aerobic or warmer chilled storage conditions; alternative responses to chilled storage periods may have been observed.

Notes

Nonetheless, this study does affirm chilled storage as a viable approach to preserve beef throughout a supply chain.

1. Porter NA, Caldwell SE, Mills KA (1995) Mechanisms of free radical oxidation of unsaturated lipids. *Lipids* 30:277-290.
2. Clayton EH, Gulliver CE, Piltz JW, Taylor RD, Blake RJ, Meyer RG (2012) Improved extraction of saturated fatty acids but not omega-3 fatty acids from sheep red blood cells using a one-step extraction procedure. *Lipids* 47:719-727.

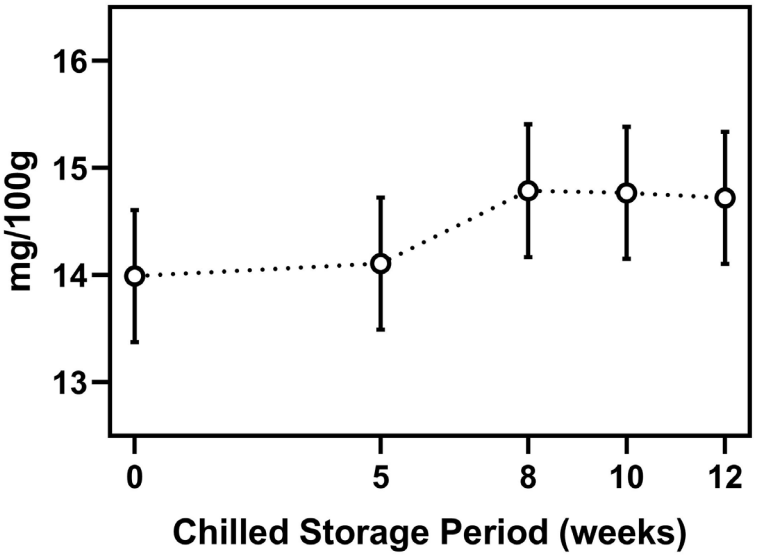

Figure 1 The total health claimable fatty acid content (EPA+DHA) of beef M. longissimus lumborum samples held chilled for up to 12 weeks. Predicted means adjusted for the covariate ± standard error (bars) are plotted.

Notes