Red meat from animals offered a grass diet increases plasma and platelet n-3 PUFA in healthy consumers.

A. J. McAfee1, E. M. McSorley1*, G. J. Cuskelly2, A. M. Fearon3, B. W. Moss3, J. A. M. Beattie3, J. M. W. Wallace1, M. P. Bonham1 and J. J. Strain1
1 School of Biomedical Sciences, Northern Ireland Centre for Food and Health, University of Ulster, Cromore Road, Coleraine BT52 1SA, Northern Ireland
2 School of Biological Sciences, Institute of Agri-Food and Land Use, Queens University, Belfast BT9 5AG, Northern Ireland
3 Agri-Food and Biosciences Institute (AFBI), Belfast BT9 5PX, Northern Ireland

(Received 12 October 2009 – Revised 5 July 2010 – Accepted 6 July 2010 – First published online 1 September 2010)

Abstract
Red meat from grass-fed animals, compared with concentrate-fed animals, contains increased concentrations of long-chain (LC) n-3 PUFA. However, the effects of red meat consumption from grass-fed animals on consumer blood concentrations of LC n-3 PUFA are unknown. The aim of the present study was to compare the effects on plasma and platelet LC n-3 PUFA status of consuming red meat produced from either grass-fed animals or concentrate-fed animals. A randomised, double-blinded, dietary intervention study was carried out for 4 weeks on healthy subjects who replaced their habitual red meat intake with three portions per week of red meat (beef and lamb) from animals offered a finishing diet of either grass or concentrate (n 20 consumers). Plasma and platelet fatty acid composition, dietary intake, blood pressure, and serum lipids and lipoproteins were analysed at baseline and post-intervention. Dietary intakes of total n-3 PUFA, as well as plasma and platelet concentrations of LC n-3 PUFA, were significantly higher in those subjects who consumed red meat from grass-fed animals compared with those who consumed red meat from concentrate-fed animals (P,0·05). No significant differences in concentrations of serum cholesterol, TAG or blood pressure were observed between groups. Consuming red meat from grass-fed animals compared with concentrate-fed animals as part of the habitual diet can significantly increase consumer plasma and platelet LC n-3 PUFA status. As a result, red meat from grass-fed animals may contribute to dietary intakes of LC n-3 PUFA in populations where red meat is habitually consumed.

Discussion
The present study demonstrates that moderate consumption of red meat from grass-fed animals can contribute to increased plasma and platelet LC n-3 PUFA concentrations among healthy individuals. Sinclair et al.(19) previously reported that 500 g/d of lean beef could increase plasma concentrations of LC n-3 PUFA compared with an intake of 30–100 g/d of beef. In the present study, the approximate daily intake of red meat (67 g) is similar to the quantity which 88% of the Irish population are presently consuming(12), suggesting that it may be possible to modify total LC n-3 PUFA intakes in this population without changing dietary habits. Furthermore, this intake is below the upper limit of red meat consumption advised by the World Cancer Research Fund(23), and, as such, is not thought to cause any negative effect to health. Animals were offered grass for a 6-week period before slaughter. The LC n-3 PUFA concentrations found within meat from grass-fed animals compared well with those reported by others for beef (30,31) and lamb(2). Intake of LC n-3 PUFA when red meat from grass-fed animals was included in the diet was estimated at 65 mg/d, compared to 44 mg/d when red meat from concentrate-fed animals was consumed. The difference in LC n-3 PUFA intake between groups attributed to the red meat consumed was estimated at 18 mg/d, an acknowledgeable low intake which was nonetheless shown to contribute to increased plasma and platelet LC n-3 PUFA status. Fish consumption can make it difficult to isolate and measure the effect of meat consumption on n-3 PUFA status(32). In the present study, however, the subjects omitted fish from their diet for the 4-week study duration and were infrequent consumers of n-3 PUFA-enriched foodstuffs. The dietary data suggest that red meat was the primary component responsible for the rise in blood concentrations of LC n-3 PUFA within the group that consumed meat from grass-fed animals compared with the group that consumed meat from concentrate-fed animals. Limitations associated with dietary analysis and food composition tables must be considered in the interpretation of dietary intake data, where LC n-3 PUFA data for many foodstuffs are lacking.

In the present study, an increase in DHA status occurred within the consumers of meat from grass-fed animals. The synthesis of DHA from ALA and EPA is known to be relatively poor(33); however, it is probable that DPA could be used to synthesise some DHA in consumers of red meat. The rate of this synthesis has been proposed to be 37% in humans and was recently described in an animal study where DPA supplementation increased DHA status(16,34). As DHA synthesis occurs in a peroxisomal reaction, it is also possible that this step may be independently regulated from the typical LC n-3 PUFA elongation pathway(34). While acknowledging the complexity of DHA metabolism, it is possible that the observed increase in DHA status within the consumers of meat from grassfed animals is a result of increased DPA intakes during the intervention, which were significantly greater than intakes within the consumers of meat from concentratefed animals. In the group that consumed meat from grass-fed animals, the increase in LC n-3 PUFA concentrations in platelets was more pronounced than in plasma. As plasma is an effective short-term marker of LC n-3 PUFA status(35), it is possible that some wash-out of LC n-3 PUFA had occurred between the time of the last meal of meat from grass-fed animals and blood collection at the end of the intervention. In comparison, platelets are a better reflection of long-term LC n-3 PUFA status(35), and the significant increases observed in both plasma and platelet measures confirm the bioavailability of LC n-3 PUFA from red meat from grass-fed animals. Plasma fatty acid values measured in the present study compare well to those of similar studies, albeit where plasma phospholipids were measured(19,32,36,37). It was not surprising to observe no significant differences in serum concentrations of cholesterol, TAG or blood pressure between groups. Firstly, there is inconsistent evidence that low doses of LC n-3 PUFA can reduce total or LDL-cholesterol serum concentrations(38 – 40). Generally, the LC n-3 PUFA are recognised for their ability to decrease TAG concentrations and this potential has been shown predominantly with LC n-3 PUFA doses .450 mg/d(41). Therefore, it is probable that a combined effect of the low dose of LC n-3 PUFA received through the meat from grass-fed animals, the short study duration and the absence of hyperlipidaemia in subjects resulted in a lack of effect on TAG concentrations in the present study. In addition, there is a lack of evidence to show that LC n-3 PUFA can reduce blood pressure at low doses or in nonhypertensive individuals(42). Nonetheless, it is important to acknowledge the aspect that red meat consumption had no effect on serum cholesterol, TAG or blood pressure in the present study, as it concurs with other studies showing moderate red meat consumption has no negative effects to health(43,44). Other means of increasing LC n-3 PUFA content of meat include addition of oilseeds or fish oil in the animal diet(45 – 47). For example, Medeiros et al.(46) showed reduced concentrations of vascular cell adhesion molecule-1 in rats consuming beef from cattle offered a flaxseed-supplemented diet compared to a typical diet of maize. Moreover, another study showed human consumption of linseed-enriched animal products to cause an increase in plasma concentrations of LC n-3 PUFA(48). However, the advantages of meat from grass-fed animals are that the content of total fat, SFA or trans-fatty acids in the meat are not simultaneously increased(49), the palatability is not affected as natural levels of a-tocopherol in the grass reduce susceptibility to lipid peroxidation(29,50) and offering animals a grass diet would be more costeffective to the producer and more sustainable with respect to the environment than feeding concentrates to the animals. However, future studies should consider increasing the length of the finishing period to allow greater increments in LC n-3 PUFA concentrations in meat tissue of grass-fed animals to occur. Overall, the present study has shown that an animal diet of grass before slaughter can help to increase the LC n-3 PUFA content of red meat. Furthermore, increases in plasma and platelet concentrations of LC n-3 PUFA were observed among consumers of this meat. This observation may have implications for the red meat industry, where increased production of red meat from grass-fed animals would have greater appeal to the consumer adding marketable value to the product. Furthermore, the consumption of red meat from grass-fed animals may contribute to raising the overall LC n-3 PUFA intake closer to the recommended intake of 450 mg/d(6) without a change being made to dietary habits, which in turn would be beneficial for cardiovascular health.

Conclusions

The present study is novel in the sense that an animal diet of grass before slaughter has been shown to significantly have an impact on LC n-3 PUFA status in free-living healthy consumers of red meat and at a level of consumption similar to the present intakes among the Irish population. Overall, the results of the present study suggest that consumption of red meat from grass-fed animals may provide valuable amounts of LC n-3 PUFA to the consumer and increased production of red meat from grass-fed animals may thereby help to increase LC n-3 PUFA intakes of consumers.