THE EFFECT OF COOKING ON THE POLYUNSATURATED FATTY ACID AND CHOLESTEROL CONTENT OF LEAN LAMB AND BEEF.

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SUMMARY

The total lipid, cholesterol and individual fatty acid content of fat- trimmed lean mid-loin lamb chops and lean beef was determined for samples which had been cooked (grilled or fried) for different times. There was no difference in the total lipid or cholesterol content between raw and cooked samples when results were expressed on a fat-free dry matter basis. Cooking had no effect on the content of polyunsaturated fatty acids for the lean lamb, however there was a 18% decrease in the content of arachidonic, eicosapentaenoic and docosapentaenoic acids in the beef which had been grilled for the longest time. There was no evidence of cooking having any affect on either phospholipid hydrolysis or an increase in formation of conjugated fatty acids.

INTRODUCTION

Meat phospholipids are known to contain high proportions of long-chain polyunsaturated fatty acids such as arachidonic, eicosapentaenoic and docosapentaenoic acids (Sinclair et al. 1982). These fatty acids are the most easily oxidised components of cells with the ease of oxidation being proportional to the number of methylenes between double bonds (Dratz and Dees 1986).

The concentration of long-chain PUFA in meat is quite low (about 100 mg per 100 g meat fresh weight) however we have recently shown that ingestion of 500 g of kangaroo meat a day for 14 days was associated with a significant in the proportion of plasma esterified arachidonic acid and of long chain n-3 PUFA (Sinclair et al. 1987). This work is being repeated using more conventional red meats (beef, lamb; Traianedes et al. 1987) with the aim of differentiating between the effects of diets low in fat but rich in very lean meat from diets rich in very lean meat and meat fat.

The objective of the current investigation was to determine the effect of cooking on the stability of the polyunsaturated fatty acids in meat phospholipids.

METHODS

Samples

Lamb: Five mid-loins were purchased from five separate commercial butchers at the Queen Victoria Market in Melbourne. Each mid-loin was divided into four chops each of about 130 g. The visible fat was trimmed from each chop and then one chop from each mid-loin set was grilled in a gas stove for 30 minutes (well-done), one for 20 minutes (medium), one for 10 minutes (rare) and one left uncooked. After grilling the chops were allowed to cool on a piece of absorbent paper towel and then the meat from each was minced in a food processor.

Beef: Five pieces of rump steak (approx. 800 g) were purchased from five separate commercial outlets at the market. The visible fat was trimmed from the steak and it was then divided into six pieces each of about 100 g. One steak from each grilled in an gas stove for 15 minutes (well done), one for 10 minutes (medium), one for 5 minutes (rare) and one left uncooked. An additional piece was fried without added fat or oil in a teflon-coated frypan for 10 minutes and the remaining piece was minced and then fried as above for 5 minutes. The beef samples were thereafter treated as described above for the lamb.

Chemical Methods

Lipid analyses - the meat samples were minced in a food processor and extracted in chloroform-methanol (2:1, v/v) containing antioxidant as previously described (Sinclair and O'Dea 1987). The total lipid content was determined gravimetrically and the phospholipids were separated from the total lipids by thin layer chromatography (Sinclair et al. 1982). The methyl esters of the total and phospholipids fatty acids were formed by saponification followed by esterification (Sinclair and O'Dea 1987). The fatty acid methyl esters were separated by capillary gas liquid chromatography using a 50 metre by 0.32 mm I.D. fused silica column coated with CP Sil 88 (Chrompak, the Netherlands) and the amounts were quantified using heptadecanoic acid as the internal standard (Sinclair and O'Dea 1987).

Phospholipid classes were separated by thin layer chromatography as described by Naughton et al. 1988. The plates were viewed by staining the lipids in iodine vapour and examined particularly for evidence of hydrolysis products of phospholipids (free fatty acids and lysophospholipids). Diene and triene conjugation of total fatty acid methyl esters was examined by UV scanning spectroscopy in an Hitachi double beam spectrophotometer.

The cholesterol content was determined by capillary gas liquid chromatography using a 25 m x 0.22 mm I.D fused silica bonded-phase (BP-1 (S.G.E. Pty Ltd). Dihydrocholesterol (5-α-cholestanol) was used as an

Table 1:
The effect of cooking on the total lipid and cholesterol content of lean lamb and beef (per 100g fat-free dry matter).

Meat	Cooking Method	Total Lipid (g)	Cholesterol (mg)
Lamb:			
Raw		41.0 ± 5.7	290 ± 8
Rare	Grilled	39.8 ± 2.2	291 ± 16
Medium	Grilled	37.0 ± 2.3	310 ± 6
Well Done	Grilled	38.3 ± 1.7	289 ± 9
Beef:			
Raw		20.1 ± 3.4	230 ± 11
Rare	Grilled	15.8 ± 1.3	236 ± 12
Medium	Grilled	20.8 ± 3.7	255 ± 5
Well done	Grilled	17.2 ± 1.4	244 ± 10
Minced	Pan Fried	16.5 ± 1.5	237 ± 4
Fried	Pan Fried	23.3 ± 4.6	238 ± 5

Results expressed as mean ± SEM. There were five samples analysed for each cooking method.

Table 2:

The effect of cooking on the mean content of different polyunsaturated fatty acids in lean lamb and beef (per 100g fat-free dry matter).

Meat	Cooking Method	Fatty Acid 18:2	18:3	20:4	20:5	22:5
Lamb:						
Raw		23	10	10	9	7
Rare	Grilled	23	9	10	9	6
Medium	Grilled	26	11	11	10	7
Well done	Grilled	25	10	10	10	7
Beef:						
Raw		29	8	17	11	11
Rare	Grilled	28	8	15	10a	10a
Medium	Grilled	26	8	15	9b	9a
Well done	Grilled	27	8	14a	9b	9a
Minced	Fried	30	9	15a	10	10
Fried		26	8	16	10	11

Paired t-test comparing raw meat with the various types of cooked meats, a $p<0.05$, b $p<0.01$.

internal standard. Aliquots of the total lipid plus cholestanol were saponified, extracted and then derivatized with BSTFA in pyridine for 30 minutes at room temperature.

Moisture content was determined on a 2 g aliquot by heating in an oven at 105°C for 24 hours.

Statistical analyses.

The paired t-test was used to compare results within a study.

RESULTS AND DISCUSSION

The results have been expressed on a fat-free dry matter basis because of the loss of both moisture and lipid with cooking. The lean raw lamb chops had a lipid content of 8.6 g, a cholesterol content of 61 mg and a water content of 70.6 g per 100 g fresh weight. The lean beef contained 4.3 g lipid, 49 mg cholesterol and 74.3 g of water per 100 g fresh weight.

There was no significant change in lipid or cholesterol content of either lamb or beef with cooking (Table 1). The phospholipid polyunsaturated fatty acid content was not significantly affected by cooking for the lean lamb (Table 2) whereas for the lean beef there were significant decreases in the arachidonate, eicosapentaenoate and docosapentaenoate content for some types of cooking. A consistent decrease of about 18% in these three fatty acids occurred when the samples were grilled for 15 minutes (designated well done).

There was no evidence with either the lamb or beef that cooking led to an increase in products associated with phospholipid hydrolysis (free fatty acids and lysophospholipids), or in the appearance of diene or triene conjugation in either the methyl esters of the total lipids or the phospholipids.

Previous studies on the effect of cooking on the fatty acid composition of the intramuscular phospholipids or total lipids have found no difference between the proportion of polyunsaturated fatty acids in raw and cooked samples of beef, although the most highly unsaturated fatty acids were not determined in these studies (Terrel et al. 1968, Anderson et al. 1971, Janicki and Appledorf 1974).

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