EFFECT OF COOKING ON THE LIPID COMPOSITION OF BEEF STEAKS

S.K.Duckett[1] , D.G.Wagner[2], H.G.Dolezal[3], L.D.Yates[4], A.C.Clutter[4] and S.G.May[1]

Story in Brief

Forty-eight rib steaks from steers serially slaughtered at 28 day intervals (0-196 days-on-feed) were used to assess the effect of cooking on the lipid composition of beef. Rib steaks were sectioned into lateral and dorsal halves after removal of all exterior fat and epimysial connective tissue. The dorsal half was broiled to an internal temperature of 158°F, a medium degree of doneness. Moisture, lipid and fatty acid content of both halves were examined. Cooking loss averaged 34.5%. Moisture content decreased with cooking an average of 20.4%. Total lipid and neutral lipid increased 15.3% and 13.9%, respectively, with cooking. Cooking increased polar lipid concentrations 54%. Saturated fatty acids increased 3.9% while the monounsaturated fatty acids and polyunsaturated fatty acids decreased 2.1% and 2.0%, repectively, with cooking. Cooking changed the saturated to unsaturated fatty acid ratio from .97 to 1.13.

(Key Words: Beef, Cooking, Lipids, Fatty Acids.)

Introduction

In 1989, per capita beef consumption was 1.5 oz./day, cooked weight basis (USDA, 1989). Beef consumption peaked in 1976 but has since declined due to cost factors and increased concern over diet health issues. Today's consumers are questioning if beef can fit into a healthy diet. The American Heart Association (AHA, 1985) recommends that adults consume 30% or less of their total daily coloric intake from fat, 10% or less of their daily caloric intake from saturated fats, and 300 mg or less cholesterol per day. The AHA also recommend that adults need no more that 6 oz. of meat, poultry or seafood per day (about two small, 3 oz. servings). If an adult consumes 2000 calories per day, a 3 oz. serving of cooked lean beef would contribute 4.0% and 1.6% of their daily caloric intake from fat and saturated fat, respectively, and 23% of the

[1]Graduate Student [2]Regents Professor and Department Head [3]Associate Professor [4]Assistant Professor

recommended daily cholesterol intake while contributing essential amino acids, B vitamins, zinc and iron (USDA, 1990).

Based on these figures, beef can fit into a healthy diet as prescribed by the AHA. However, the concern lies in the values calculated for cooked products. Limited research is available as to changes in lipid concentrations and fatty acid composition that may take place during cooking. Most of the values for small portion sizes have been extrapolated from cooking 8-12 oz. steaks. Another factor important in calculation of these values is in determining the accurate SFA content. Stearic acid (C18:0), a saturated fatty acid, has been shown to have little or no effect on serum cholesterol levels (Hegsted, 1965). Work by Bonanome and Grundy (1988), showed that a high stearic acid diet lowered serum cholesterol 14% compared to a diet high in palmitic acid (C16:0). Thus the belief is that a corrected SFA content should be calculated (%SFA - %C18:0) to most accurately predict negative effects on serum cholesterol. The objective of this study was to assess the effect cooking may have on the moisture, lipid and fatty acid content of beef steaks.

Materials and Methods

Forty-eight steaks from the 9th rib of Angus x Hereford steers serially slaughtered at 28 day intervals (0-196 days-on-feed (DOF)) were sectioned into lateral (RAW) and dorsal (COOK) halves after removal of all exterior fat and the epimysial connective tissue. Dorsal halves, approximately 4 oz., were broiled to an internal temperature of 158°F, a medium degree of doneness. Both RAW and COOK halves were pulverized in liquid nitrogen and stored at -22°F until subsequent chemical analyses.

Both RAW and COOK were analyzed for moisture, lipid and fatty acid content. Duplicate samples were dried at 216°F for 24 hours to determine moisture content Samples were then solvent extracted to obtain two fractions: neutral lipid (NL) and polar lipid (PL). The NL contains mono-, di-, and triglycerides while the PL contains the phospholipids. Aliquots from both the NL and PL were dried at 216°F for 24 hours after solvent removal to determine percent lipid. The percent lipid in the NL and PL were then added to obtain the total lipid (TL) content. Approximately 40 mg of NL and PL were esterified and analyzed using a HP5890A Gas Chromatograph to obtain fatty acid profiles.

Data were analyzed using the split-plot analysis of variance with animal considered the whole plot and steak as the sub plot.

Results and Discussion

Moisture and lipid composition of the longissimus muscle (LM) are reported in Table 1. Cooking loss averaged 34.5%. Moisture content decreased

Table 1. Moisture and lipid composition of the longissimus muscle.

		Days-on-Feed (DOF)								
Percent	Trt	0	28	56	84	112	140	168	196	SEM
Moisture[ac]	Raw	74.59	74.08	73.32	73.64	70.45	68.93	68.59	67.47	1.13
	Cook	57.55	55.11	53.40	52.80	47.96	45.47	47.83	48.43	
Total Lipid[ac]	Raw	2.52	3.06	4.96	4.09	9.48	9.73	9.83	11.65	0.94
	Cook	11.82	15.32	16.60	18.42	25.50	28.42	24.89	25.64	
Neutral Lipid[ac]	Raw	1.84	2.45	4.34	3.44	8.88	9.03	9.14	10.95	0.91
	Cook	10.57	14.20	15.49	17.23	24.28	27.15	23.68	24.42	
Polar Lipid[a]	Raw	0.68	0.61	0.61	0.65	0.62	0.71	0.69	0.70	0.03
	Cook	1.25	1.17	1.11	1.19	1.23	1.28	1.21	1.19	
Cooking Loss	Cook	34.33	35.89	33.38	35.66	34.34	33.57	34.02	34.69	1.78

[a] Treatment effect (P<.01)

[c] Treatment by DOF interaction (P<.10)

an average of 20.4%. TL, NL and PL content increased with cooking (P<.01). This increase is mainly due to the loss in moisture content incurred during cooking. The lipid values in this experiment exceed those published by the USDA (1990) for cooked beef rib steaks. This increase in lipid content would result from (1) removal of the epimysium and/or (2) using the AHA recommended serving size. These would lead to greater moisture losses and lipid concentration in the LM during cooking. These results suggest that extrapolating USDA (1990) values to predict smaller portion sizes may not be accurate.

Fatty acid changes for RAW and COOK are reported in Table 2. SFA concentration increased 3.9% with cooking (P<.01). The greatest increase was at 0 DOF. Cooking decreased monounsaturated fatty acid (MUFA) and polyunsaturated fatty acid (PUFA) concentrations 2.1% and 2.0%, respectively (P<.01). The largest loss in MUFA content occurred at 168 DOF, while the largest loss in PUFA content occurred at 0 DOF. The changes in fatty acid content with cooking increased SFA to unsaturated fatty acid (UNSFA) ratio from .97 to 1.13. The loss of the UNSFA during cooking is due to the fact that fatty acid melting points decrease with their degree of unsaturation and thus making them more susceptible to oxidation during cooking.

In summary, cooking results in moisture, MUFA and PUFA losses and consequent increases in lipid and SFA concentrations. These changes resulted in an overall increase in the SFA:UNSFA ratio with cooking such that over 50% of the fat in cooked beef rib steaks is saturated. Based on these results of this study, the contribution of 3 oz./day of cooked beef rib steak would be 8.0% and 4.2% of the daily caloric intake from fat and saturated fat, respectively. When a corrected SFA (CSFA) content is calculated (Table 3), 3 oz./day of cooked beef rib steak would contribute only 2.7% of the daily caloric intake from saturated fat .

Table 2. Fatty acid composition of the longissimus muscle.

		Days-on-Feed (DOF)								
Percent	Trt	0	28	56	84	112	140	168	196	SEM
SFA[ab]	Raw	47.30	50.24	50.90	49.70	50.61	48.26	47.14	47.79	0.32
	Cook	55.28	54.27	53.36	53.34	53.05	51.55	50.72	51.30	
MUFA[ac]	Raw	39.91	41.60	41.89	43.24	44.98	46.69	48.75	48.73	0.38
	Cook	38.57	41.09	41.29	41.41	42.08	43.86	45.04	45.29	
PUFA[ab]	Raw	12.31	8.15	6.85	7.16	4.48	4.93	4.18	3.42	0.26
	Cook	5.22	4.38	4.87	4.80	4.22	4.21	4.10	3.62	
SFA:UNSFA[ab]	Raw	0.90	1.01	1.04	0.99	1.02	0.93	0.89	0.92	0.01
	Cook	1.26	1.19	1.16	1.15	1.14	1.07	1.03	1.05	

[a] Treatment effect ($P<.01$)

[b] Treatment by DOF interaction ($P<.05$)

[c] Treatment by DOF interaction ($P<.10$)

Table 3. Stearic, oleic and corrected SFA concentrations in the longissimus muscle.

		Days-on-Feed(DOF)								
Percent	Trt	0	28	56	84	112	140	168	196	SEM
C18:0[ab]	Raw	17.36	17.38	17.80	15.72	15.71	14.29	13.38	13.92	0.28
	Cook	22.83	20.59	19.17	18.96	18.23	17.38	16.12	17.10	
C18:1[a]	Raw	34.95	36.40	36.85	38.04	38.92	40.31	41.58	41.86	0.31
	Cook	33.90	36.53	37.05	37.23	38.07	39.64	40.30	40.49	
CSFA[abc]	Raw	29.92	32.86	33.10	33.98	34.90	33.97	33.76	33.87	0.19
	Cook	32.45	33.68	34.19	34.38	35.07	34.17	34.60	34.20	

[a] Treatment effect (P<.01)

[b] Treatment by DOF interaction (P<.05)

[c] % SFA minus % C18:0

Literature Cited

AHA. 1985. The American Heart Association Diet. Circ. 51:018B.

Hegsted, D.M. et. al. 1965. Quantitative effects of dietary fat on serum cholesterol in man. Am. J. Clin. Nutr. 17:281.

Bonanome, A. and S.M. Grundy. 1988. Effect of dietary stearic acid on plasma cholesterol and lipoprotein levels. N. Engl. J. Med. 318:1244.

USDA. 1989. Livestock and Poultry Situation and Outlook Report. United States Department of Agriculture, Washington D.C.

USDA. 1990. Composition of Foods: Beef Products. Agricultural Handbook 8-13. United States Department of Agriculture, Washington, D.C. p.177.