Effect of cooking on nutrient content, cooking yields, and nutrient retentions of Beef Value Cuts

J Howe*[1], B Showell[1], J Holden[1], D Buege[2]

USDA, ARS, Nutrient Data Laboratory, Beltsville, MD, USA[1], University of Wisconsin, Madison, WI, USA[2]

INTRODUCTION

- The beef industry recently introduced to the retail market new cuts of beef, collectively known as Beef Value Cuts (BVCs).
- Beef Value Cuts are individual muscle cuts derived from the chuck and the round. These cuts will provide the consumer with tender cuts of meat at moderate prices.
- The USDA, in conjunction with America's Beef Producers, undertook a collaborative study to determine the effect of cooking on the nutrient composition of BVCs.

OBJECTIVES

- To obtain data on the nutrient content of cooked Beef Value Cuts for entry into the USDA National Nutrient Database for Standard Reference (SR).
- To determine cooking yields and nutrient retention factors of Beef Value Cuts (BVCs).

METHODS

- Sampling: Twelve beef carcasses (six select and six choice) were procured from one large processing plant, which provides products nationwide.
- Preparation: Six single-muscle cuts were fabricated into steaks from each beef carcass.
- The cuts were cooked (ckd) by grilling to an internal temperature of 160°F on a portable outdoor gas grill.
- Individual samples were used to determine proximates, B-vitamins and minerals.
- Two composites, each derived from three samples, were used in the determination of choline metabolites.
- A single nationally representative composite composed of two samples was used to prepare total folate and alpha-tocopherol samples for analysis.
- Nutrient Analyses: Proximates, cholesterol and B-vitamins were determined using standard AOAC methodology.
- Mineral content was determined using ICP.
- Choline metabolites were determined using liquid chromatography- electrospray ionization-isotope dilution mass spectrometry.[2]
- Quality Control: Quality control was monitored through the use of Standard Reference Materials (SRM), In-House control materials, and duplicate sampling.
- Calculations:

Cooking Yield = $\frac{\text{Ckd weight of food}}{\text{Raw weight of food}} \times 100$

Nutrient Retentions = 100 x $\frac{\text{Nutrient content of ckd food}}{\text{Nutrient content of raw food}} \times \text{CookingYield}$

Moisture or Fat Change = $\frac{\frac{\text{g (water or fat) x g ckd food}}{\text{100 g ckd food}} - \frac{\text{g (water or fat) x g raw food}}{\text{100 g raw food}}}{\text{g raw food}} \times 100$

- Statistics: Data was statistically evaluated using the Proc Mixed procedure of SAS[3]; the critical level of significance was set at P<0.05.

Table 1. Nutrient Content of Cooked Beef Value Cuts[1]

	INF	TB	TM	BF	RF	VL	S.E.M.
Proximates (g)							
Protein(n=10)[2]	24.81^{a}	26.13^{b}	26.20^{b}	27.23^{b}	26.46^{b}	28.88^{c}	0.433
Fat (n=10)[2]	12.65^{a}	7.79^{b}	7.21^{b}	7.51^{b}	7.19^{b}	4.94^{c}	0.535
Ash (n=10)[2]	0.96^{a}	1.07^{b}	1.04^{b}	1.16^{c}	0.91^{a}	1.16^{c}	0.020
Water (n=10)[2]	61.92^{a}	64.84^{b}	65.55^{b}	64.29^{b}	65.46^{b}	65.49^{b}	0.492
Selected Nutrients and Minerals (mg)							
Cholesterol (n=10)[2]	82.72^{a}	75.52^{cd}	77.89^{bc}	77.00^{cd}	74.77^{d}	80.67^{ab}	1.195
Iron (n=3)[2]	2.88^{ab}	2.79^{ab}	2.59^{bc}	2.99^{a}	2.51^{c}	2.77^{abc}	0.105
Sodium (n=3)[2]	77.10^{a}	60.33^{b}	59.43^{bc}	57.73^{bc}	51.63^{d}	53.90^{cd}	1.791
Thiamin (n=3)	0.07	0.07	0.08	0.07	0.06	0.08	0.012
Riboflavin (n=3)[2]	0.29^{a}	0.29^{a}	0.25^{ab}	0.21^{b}	0.22^{b}	0.20^{b}	0.018
Niacin (n=3)[2]	3.83^{c}	5.27^{b}	5.19^{bc}	7.56^{a}	5.18^{bc}	5.87^{b}	0.401
Zinc (n=3)[2]	9.19^{a}	7.21^{b}	5.23^{c}	5.25^{c}	6.98^{b}	7.45^{b}	0.493
Composite Analyses (mg)							
Total Choline[3]	106.83	98.96	107.86	92.87	104.26	102.63	--
Betaine[3]	14.24	14.85	14.53	11.99	13.46	11.51	--
Total Folate[4]	11.00	10.00	7.00	8.00	8.00	7.00	--
alpha-Tocopherol[4]	0.18	0.20	0.14	0.20	0.17	0.10	--

[1]Values are Least Squares Means; Standard Errors of LS Means are shown in the last column.
[2]Values within a row with similar superscripts are not significantly different at P < 0.05 (ANOVA).
[3]Values for Total Choline and Betaine were determined from two nationally representative composites of 3 samples each.
[4]Values for Total Folate and α-Tocopherol were determined from a single nationally representative composite of 2 samples.

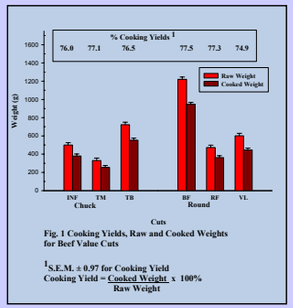

Fig. 1 Cooking Yields, Raw and Cooked Weights for Beef Value Cuts

[1]S.E.M. ± 0.97 for Cooking Yield
Cooking Yield = Cooked Weight x 100% / Raw Weight

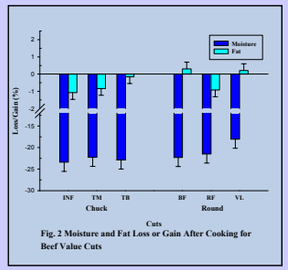

Fig. 2 Moisture and Fat Loss or Gain After Cooking for Beef Value Cuts

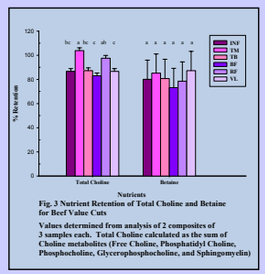

Fig. 3 Nutrient Retention of Total Choline and Betaine for Beef Value Cuts

Values determined from analysis of 2 composites of 3 samples each. Total Choline calculated as the sum of Choline metabolites (Free Choline, Phosphatidyl Choline, Phosphocholine, Glycerophosphocholine, and Sphingomyelin)

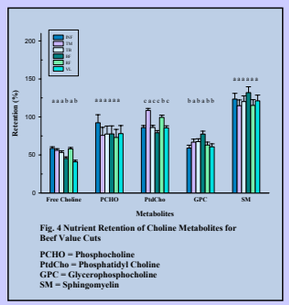

Fig. 4 Nutrient Retention of Choline Metabolites for Beef Value Cuts

PCHO = Phosphocholine
PtdCho = Phosphatidyl Choline
GPC = Glycerophosphocholine
SM = Sphingomyelin

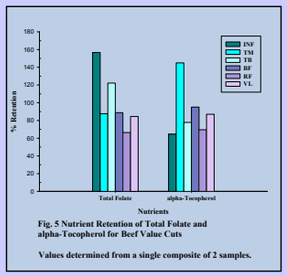

Fig. 5 Nutrient Retention of Total Folate and alpha-Tocopherol for Beef Value Cuts

Values determined from a single composite of 2 samples.

Table 2. Nutrient Retention Factors for Beef Value Cuts (%)[1]

	INF	TB	TM	BF	RF	VL	S.E.M.
Minerals							
Calcium	82.98	83.53	83.54	77.88	85.23	82.79	4.180
Iron	93.13	92.41	93.71	91.96	97.49	92.36	2.851
Magnesium	82.96	80.39	81.76	81.66	83.22	78.93	2.606
Phosphorous	83.73	82.47	84.45	85.42	85.27	82.36	2.576
Potassium[2]	79.40^{ab}	77.83^{ab}	79.15^{ab}	81.60^{a}	79.47^{a}	71.08^{b}	3.151
Sodium[2]	78.93^{a}	77.51^{a}	76.72^{a}	71.80^{ab}	73.75^{ab}	66.07^{b}	3.056
Zinc	100.06	98.67	98.67	100.01	98.55	102.42	3.457
Manganese	81.31	75.17	79.69	86.54	76.42	80.67	14.794
Selenium	96.80	104.60	95.77	104.36	98.73	99.78	3.189
Vitamins							
Thiamin	66.76	72.05	69.34	70.27	60.51	95.25	9.505
Riboflavin	96.54	93.68	77.71	80.15	92.39	81.23	9.566
Niacin[2]	90.00^{ab}	77.06^{ab}	81.72^{ab}	91.69^{a}	79.45^{b}	78.33^{b}	4.468
Pantothenic Acid	76.77	82.72	80.24	89.23	78.30	77.76	4.987
Vitamin B_6[2]	80.00^{ab}	68.02^{bc}	88.72^{a}	72.17^{bc}	72.06^{bc}	67.37^{c}	4.401
Vitamin B_{12}[2]	90.83^{a}	96.57^{a}	91.26^{a}	75.96^{a}	55.05^{b}	101.16^{a}	6.628

[1] Values are Least Squares Means; Standard Errors of LS Means are shown in the last column; n=3.
[2]Values within a row with similar superscripts are not significantly different at P < 0.05 (ANOVA).

COMMON FIGURE LEGEND

- INF – Infraspinatus
- TM – Teres Major
- TB – Triceps Brachii
- BF – Bicep Femoris
- RF – Rectus Femoris
- VL – Vastus Lateralis
- Bar height represents Least Squares Means ± S.E.M.
- Bars with similar superscripts are not significantly different within a nutrient.

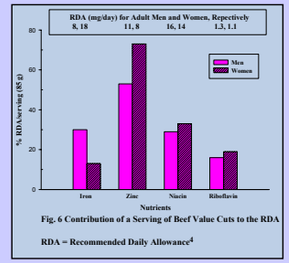

Fig. 6 Contribution of a Serving of Beef Value Cuts to the RDA

RDA = Recommended Daily Allowance[4]

RESULTS

- Fat concentration was the greatest in INF, and lowest in VL (Table 1).
- Nutrient retention factors were generally similar among BVCs. Potassium, sodium, niacin, and vitamins B_6 and B_{12} had the greatest variability in nutrient retention factors among cuts (Table 2).
- BF had the highest cooking yield among both round- and chuck-derived cuts; Cooking yields were similar among cuts (Fig. 1).
- Fat was concentrated in BF and VL during cooking, resulting in an apparent fat gain (Fig. 2).
- Within their respective primals, TM and RF had the highest levels of total choline and phosphatidyl choline retention. There were no significant differences in retention of betaine across all cuts (Fig. 3,4).
- Chuck-derived cuts had greater total folate retention than cuts derived from the round (Fig. 5).
- Single servings of BVC provide greater than 50% of the RDA for zinc as well as 10% -33% of the RDA for iron, niacin, and riboflavin (Fig. 6).

CONCLUSIONS

- BVCs are good sources of zinc, iron, niacin and riboflavin.
- Muscle fibers for BF were more dense than those of other cuts, which may have deterred fat loss. The fat gain observed for BF may have resulted from a conservation of fat in this cut (Fig. 2).
- VL had less fat available for loss. The fat gain in VL may be due to the concentration effect of moisture loss during cooking.
- BVCs are good sources of choline. Eighty per cent (80%) of total choline is derived from PtdCho, which is well retained during grilling (>80% retention).

REFERENCES

1. U.S. Department of Agriculture, Agricultural Research Service. 2004. USDA National Nutrient Database for Standard Reference, Release 17. Nutrient Data Laboratory Home Page, http://www.nal.usda.gov/fnic/foodcomp.
2. Zeisel SH, Mar MH, Howe JC, Holden JM. Concentrations of choline-containing compounds and betaine in common foods. *J. Nutr.* 2003; 133(5): 1302-1307.
3. The SAS System (version 8), SAS Institute Inc., Cary, NC 27513.
4. Institute of Medicine of the National Academies.Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate. The National Academies Press. 2004; 6: 1-146.