Effect of Meat Type and Cooking Method on Cooking Yields

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INTRODUCTION

The Nutrient Data Laboratory (NDL) at the USDA conducts food composition research to develop accurate, unbiased, and representative food and nutrient composition data which are released as the USDA National Nutrient Database for Standard Reference (SR).

SR is used as the foundation of most other food composition databases in the U.S. and worldwide to monitor food and nutrient intake, conduct human nutrition research, label foods, and develop nutrition policy.

USDA food composition data support efforts of the USDA Food Safety and Information Service (FSIS) and the retail meat industry to initiate single ingredient meat labeling [1] which became mandatory in March 2012.

Since the 1950's, USDA has also released cooking yield tables that describe changes in food weight due to moisture loss (e.g. evaporation, moisture drip), water absorption , or fat gains/losses during food preparation. Cooking yields are used in food formulations and recipes to convert nutrient values for uncooked foods into values for cooked foods.

NDL has conducted several collaborative studies with scientists in the meat industry and universities to update values on cooking yields in meats. These data are used to develop nutrient values for moisture, fat, vitamins and minerals. To maintain the quality of cooking yield data, it is essential to review and update existing data and acquire new data as needed .

This report summarizes the results of multiple studies which indicate the impact of meat type, cooking method, and fat content on the amount of cooking yield and the extent of moisture and fat changes that occur during cooking.

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MATERIALS & METHODS

Sampling: Pork cuts and ground beef were purchased from 12 to 24 retail outlets nationwide using sampling plans developed for the National Food and Nutrient Analysis Program [2,3]. Beef cuts, ground pork and game meats were obtained from US commercial processing plants or feedlots. Statistical sampling plans were designed to provide nationally representative data.

Preparation:
Beef pot roasts were browned, then simmered in water in tightly covered pan in oven. Cooking liquid volume was documented.

Pork shoulders were placed on rack in roasting pan for braising, with water added. Cuts were braised in covered pan in oven until tender, cooled for 5 minutes, then weighed.

Beef steaks were grilled to final internal temperature of 70° C and weighed when removed from grill.

Pork blade chops were grilled for 10 minutes, removed from grill, and monitored until final internal temperature was attained.

Beef rib roasts and pork loin roasts were roasted in uncovered pans with no oil or water added.

Unless otherwise noted above, samples were allowed to stand after cooking while monitoring the rise in internal temperature in order to obtain a peak temperature, which was considered the final internal temperature (Table 1A).

Weights were obtained for both raw and cooked samples.

Nutrient analysis: Raw and cooked meat samples were chemically analyzed. Moisture content was determined using AOAC method 950.46 [4]. Fat was determined using the acid hydrolysis method (AOAC 954.02 [4]) or chloroform/methanol method (Folch et al. [5]).

Quality control: Analytical quality control was assured using standard reference materials and in-house control materials**.**

Calculations: Cooking yields were calculated from the initial (raw) and final hot cooked (ckd) weights according to the following formula:

$$Yield\ \% = \frac{cooked\ sample\ ckd\ weight}{cooked\ sampled\ raw\ weight} \times 100$$

The change in nutrient content between raw and cooked products was used to estimate moisture loss and fat loss during cooking. The equation below was used to calculate % moisture change, where EP is edible portion . The equation used for % fat change was the same except that fat values were substituted for water values.

$$\frac{\frac{g\ water\ \ ckd\ EP}{100\ g\ ckd\ EP} \times g\ ckd\ EP - \frac{g\ water\ \ raw\ EP}{100\ g\ raw\ EP} \times g\ raw\ EP}{g\ raw\ cut\ as\ marketed}$$

Note: To calculate % moisture and fat change for pork cuts in this report, EP consisted of the lean only portions; EP for beef cuts and ground products were comprised of lean and fat portions.

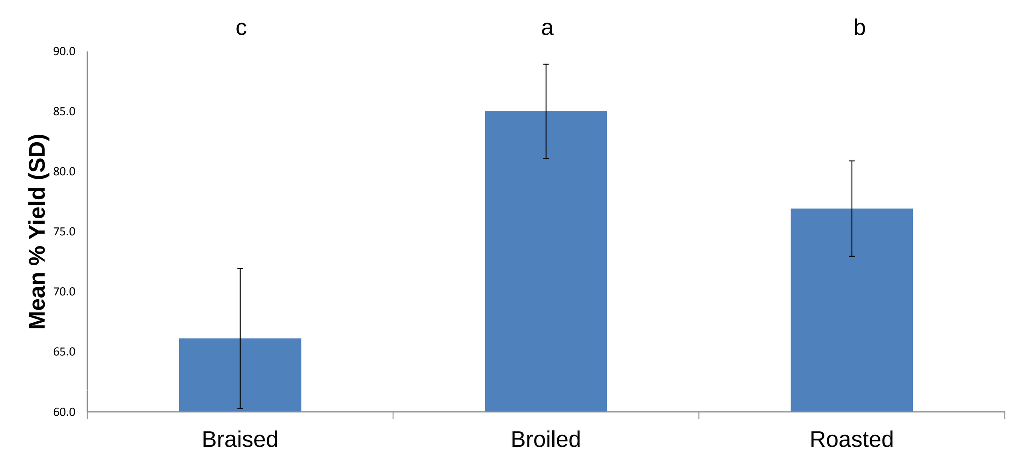
Statistics: Means, standard deviations and frequencies were used to generate one-way analysis of variance (ANOVA) to test the statistical significance of differences in cooking yields due to meat source, cut/cooking method within beef and within pork, and ground product fat category (high, medium, and low) within beef and within pork. Tukey's HSD method was incorporated as needed in the analysis to identify significant differences in means. The same method of analysis was used for moisture change and fat change where data were available.

Table 1A: Effects of cooking on cooking yields, moisture and fat change in beef and pork cuts

Meat Source	Cuts	Cooking Method[1] (Oven Temp)/Final Temperature	n	% Cooking Yield Mean[2] (SD)	% Cooking Yield P-value[3]	% Moisture Change[4] Mean[2] (SD)	% Moisture Change[4] P-value[3]	% Fat Change[4] Mean[2] (SD)	% Fat Change[4] P-value[3]
Beef	Shoulder pot roast, boneless, trimmed to 0" fat, all grades	Braised (250°F) / 85°C	68-71	66[c] (6.1)	<0.0001	-34[a] (18.1)	<0.0001	0.4[c] (2.2)	<0.0001
	Rib eye steak, bone-in, lip-on, trimmed to 1/8" fat, all grades	Broiled / 70°C	36	86[a] (4.0)		-16[b] (4.8)		-1.1[b] (2.9)	
	Rib eye roast, bone-in, trimmed to 1/8" fat, all grades	Roasted (325°F) / 60°C	34-35	77[b] (2.9)		-16[b] (6.7)		-3.6[a] (4.2)	
Pork	Shoulder, Boston butt, blade steaks	Braised (325°F)/ 85°C	11-12	65[c] (3.1)	<0.0001	-36[a] (2.8)	<0.0001	2.9[a] (2.2)	0.5650
	Loin, bone-in, blade chops	Broiled / 71°C	10-12	83[a] (3.1)		-18[c] (1.8)		2.3[a] (1.1)	
	Loin, bone-in, center loin roast	Roasted (425°F) / 71°C	10-12	77[b] (6.4)		-24[b] (3.5)		2.3[a] (0.9)	

[1]Broiled refers to both broiled and grilled.
[2]Means with any identical letters within meat source are not significantly different at p<0.05 (Tukey's HSD).
[3]Probabilities determined by one-way ANOVA.
[4]For beef, moisture and fat changes are computed for edible portion (lean+fat), while for pork, moisture and fat changes are for lean only.

Figure 1: Effect of cooking method on cooking yields for beef and pork cuts



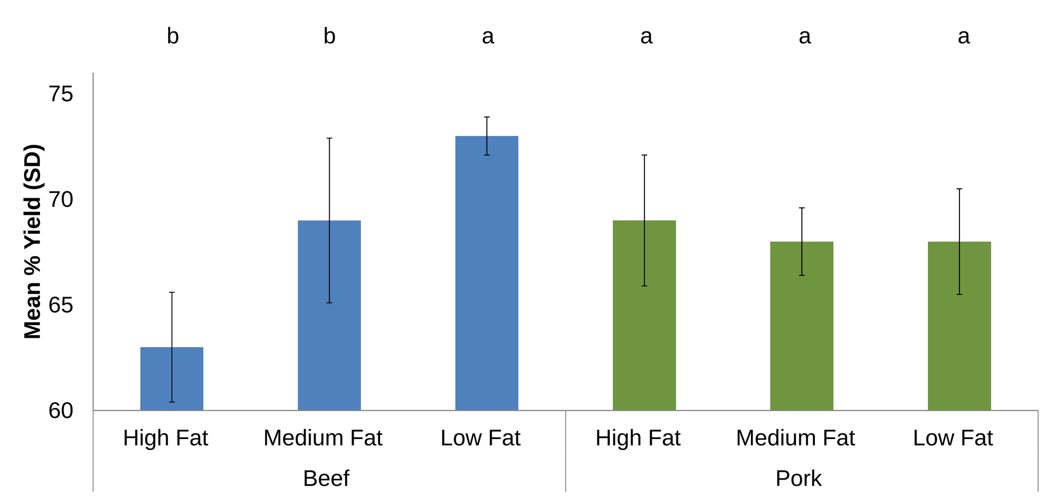
Yield values with same superscript are not significantly different at p<0.05 (Tukey's HSD).

Table 1B: Effects of cooking on cooking yields, moisture and fat change in ground meats

Cuts	Cooking Method[1] (Oven Temp) / Final Temperature	n	% Cooking Yield	SD	% Moisture Change	% Fat Change
Beef,ground, patty, high fat (>22% fat)	Broiled / 71°C	4	63	2.6	-24	-12
Beef, ground, patty, medium fat (12%-22% fat)	Broiled / 71°C	4	69	3.9	-25	-5.2
Beef,ground, patty low fat (<12% fat)	Broiled / 71°C	4	73	0.9	-24	-1.6
Pork, ground, patty, high fat (>27% fat)	Broiled / 74°C	4	69	3.1	-25	-6.6
Pork, ground, patty, medium fat (10%-27% fat)	Broiled / 74°C	4	68	1.6	-27	-1.9
Pork, ground, patty, low fat (<10% fat)	Broiled / 74°C	4	68	2.5	-33	0.2
Elk, ground (8.7% fat)	Broiled / 71°C	5	84	3.7	-15	-1.5
Emu, ground (4.6% fat)	Broiled / 71°C	6	80	6.8	-20	-0.2
Bison, ground (15% fat)	Broiled / 71°C	6	77	1.3	-18	-4.2
Ostrich, ground (7.1% fat)	Broiled / 71°C	6	86	2.5	-13	-2.7
Deer, ground (8.2% fat)	Broiled / 71°C	3	83	1.9	-18	-0.1

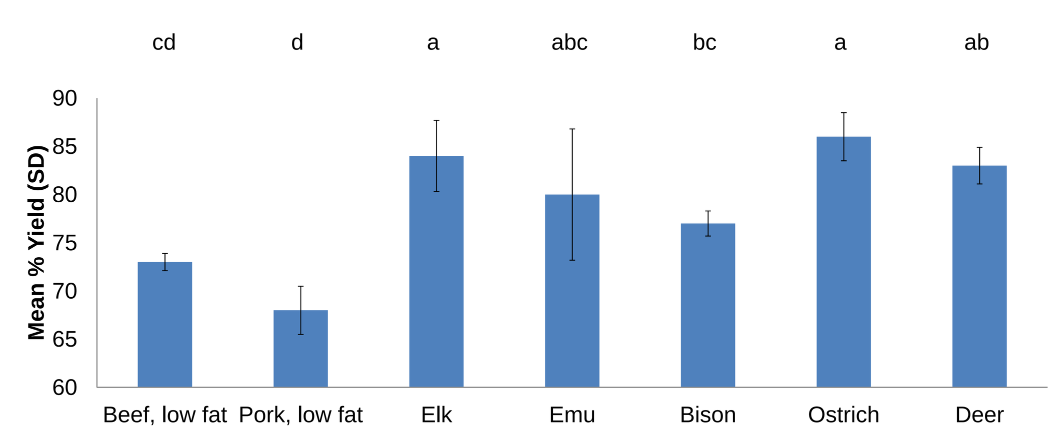
[1]Broiled refers to both broiled and grilled

Figure 2: Cooking yields for broiled ground beef and pork at 3 fat levels



Yield values with same superscript within a meat type are not significantly different at p<0.05 (Tukey's HSD).

Figure 3: Cooking yields for 7 types of ground meat



Yield values with same superscripts are not significantly different at p<0.05 (Tukey's HSD).

RESULTS & DISCUSSION

- Cooking yields, moisture change and fat change for beef cuts differed according to cut/cooking method used (p<0.0001, Table 1A).

- Cooking yields for comparable beef and pork cuts varied according to cooking method used with broiling resulting in the highest yields (p<0.0001, Figure 1). For pork, although cooking yields and moisture changes differed according to cut/cooking method (p<0.0001), there was no difference in fat change. Regardless of cooking method, pork cuts had increased fat content.

- Cooking yields were inversely related to fat levels in ground beef products studied (p<0.0020, Table 1B).

- No significant differences in ground pork yields were seen among the 3 fat levels (Figure 2).

- Among 7 types of ground meats, ground pork had the lowest cooking yield, which was significantly different than the yields for all the other ground meat sources (p<0.0001), except ground beef (Figure 3).

SUMMARY & CONCLUSIONS

The data from these studies can be used for developing nutrient estimates for foods, as well as for making decisions where maximizing cooking yields is a desired outcome. These cooking yield data provide valuable information regarding the impact of cooking methods, meat type, and fat content on total cooking yield as well as moisture and fat gain or loss.

Cooking yield data from these studies will be released in USDA 's Meat Cooking Yields tables at *http://www.ars.usda.gov/nutrientdata.*

USDA yield data provide researchers, nutrition professionals, industry officials, and consumers with important information and for making decisions regarding food plans and food preparation.

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