



**AgEcon** SEARCH  
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

*The World's Largest Open Access Agricultural & Applied Economics Digital Library*

**This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.**

**Help ensure our sustainability.**

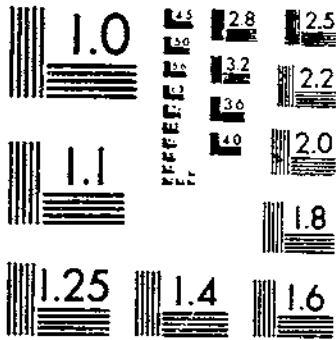
Give to AgEcon Search

AgEcon Search  
<http://ageconsearch.umn.edu>  
[aesearch@umn.edu](mailto:aesearch@umn.edu)

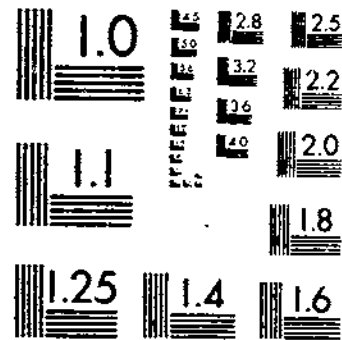
*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

TB 1137-1955 USDA TECHNICAL BULLETINS USDA  
BONELESS BEEF RAW, COOKED, AND SERVED - RESULTS OF ANALYSES FOR MOISTURE  
TOEPEER, E. W. PRITCHETT, C. S. HENSTON, E. M. 1 OF 1

# START



MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A



MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A

630  
2031  
1137

REFERENCE  
DO NOT LOAN

DECEMBER 1955

# BONELESS BEEF: RAW, COOKED, AND SERVED ...

## Results of Analyses for Moisture, Protein, Fat, and Ash

By Edward W. Toepfer, Claud S. Pritchett, and Elizabeth M. Hewston  
Human Nutrition Research Branch  
Agricultural Research Service

Los Angeles Public Library

MAR 7 1956

DEPOSITORY



Technical Bulletin No. 1137

UNITED STATES DEPARTMENT OF AGRICULTURE

## Acknowledgments

These studies of boneless beef were made possible through the encouragement and support of Maj. Gen. Herman Feldman, The Quartermaster General, Department of the Army; and Dr. Hazel K. Stiebeling, Director of Human Nutrition and Home Economics Research, Agricultural Research Service, United States Department of Agriculture.

Of the many persons connected with the Department of the Army and other organizations and institutions associated with this work, the authors gratefully acknowledge participation in the planning by: Jane C. Ebbs, Robert L. Graf, Lt. Col. Harry Keeny, E. M. Kenyon, James J. Klaer, Paul C. Doss, R. P. Benedict, D. K. Tressler, Lt. Col. G. W. Baccus, and Maj. T. N. Moore, Office of The Quartermaster General, Department of the Army; Col. Russell McNellis and Lt. Col. Carl J. Koehn, Office of The Surgeon General, Department of the Army; Clive M. McCay, Cornell University; H. E. Robinson, Swift & Company; and LeRoy Voris, National Research Council.

The studies at Fort Lee, Va., were made possible by the support of Maj. Gen. R. C. L. Craham, Maj. Gen. A. T. McNamara, Brig. Gen. Everett Busch, Col. A. T. McGuckian, and Maj. Norman Beacht. Operations at 5 field locations were conducted by Lt. Lloyd Platzke, Lt. Kurt Korureich, and more than 50 members of a test team selected from Army personnel.

Participation of personnel of the Agricultural Research Service, United States Department of Agriculture, is gratefully acknowledged, with special mention of M. J. MacArthur, E. F. Dochterman, W. F. Martin, H. J. Wright, and Harold Lichtenstein.

The studies reported were conducted in part with funds from the Office of The Quartermaster General, Department of the Army, and in part with funds from the Human Nutrition Research Branch, Agricultural Research Service, United States Department of Agriculture.

## Contents

	Page		Page
Summary.....	1	Part II. Plate waste from oven roasts, etc.—Continued	
Introduction.....	2	Results—Continued	
Part I. Carcass yields and composition of cuts and forms of 4-way boneless beef, cooked by Army procedures and standardized recipes.....	3	Composition of recoverable items, including plate waste.....	18
Cuts and forms of 4-way boneless beef.....	3	Protein and fat consumed.....	18
Procedures.....	4	Part III. Composition of boneless beef as cooked and served, and the amounts of protein, fat, and food energy in beef or beef recipe consumed.....	21
Results.....	6	Procedures.....	21
Carcass yields of 4-way boneless beef.....	6	Results.....	23
Cooked yields.....	7	Physical data.....	23
Composition of raw and cooked boneless beef.....	10	Composition data.....	26
Percentages of lean and of separable fat.....	13	Protein and fat in raw beef from eight carcasses and from field study.....	29
Part II. Plate waste from oven roasts, trimmed and untrimmed.....	16	Protein and fat content and energy value of beef consumed.....	30
Procedures.....	16	Literature cited.....	32
Results.....	16		
Raw beef, cooked and served items, and plate waste.....	16		

# BONELESS BEEF: RAW, COOKED, AND SERVED...



## Results of Analyses for Moisture, Protein, Fat, and Ash<sup>1</sup>

By EDWARD W. TOEFFER, CLAUD S. PRITCHETT, AND ELIZABETH M. HEWSTON  
HUMAN NUTRITION RESEARCH BRANCH, AGRICULTURAL RESEARCH SERVICE

### Summary

To obtain composition data and related information on boneless beef used in feeding programs of the United States Armed Services, studies were made of 4-way boneless beef from 8 representative carcasses, raw and cooked, and including related items from preparation and cooking; of beef in plate waste in a limited number of beef roasts from general issue, cooked and served in Army messes; and of 4-way boneless beef representative of large-scale regular issue, cooked and served in Army messes in 5 field locations. All the beef was cut according to Army specifications, which call for the processing of the carcass to provide 7 boneless cuts for oven roasts or griddle-broiled steaks, 5 cuts for pot roasts or Swiss steaks, diced meat for stew, and ground meat for such recipes as hamburger and meat loaf.

During the cutting of the 8 carcasses, the yields by weight of the various cuts were obtained. The proximate composition of the cuts, raw and cooked, was determined by analysis; a cut from one side was used as the raw sample and the corresponding cut from the other side was cooked. On a carcass basis, food energy retention in the cooked cuts was 85 percent; protein, 94 percent; and fat, 82 percent.

At one location a study was also made of the effect on plate waste of trimming surface fat from oven roasts before cooking. Roasts from general procurement sources of the Army were used. It was found that moderate trimming decreased fat in plate waste without apparent reduction in fat presumed eaten. Fat trimming by the meat processors would imply reduction not only of fat losses in the kitchen and during cooking but also of weight to be handled and stored in valuable freezing space.

In the field study, the composition of boneless beef, raw, cooked, and served, and of the corresponding plate waste was determined from samples involving 52,682 pounds of raw boneless beef cooked and

<sup>1</sup>Submitted for publication July 1, 1955.

served in 542 Army messes to 109,682 men. Plate waste increased with the amount of raw beef issued to the mess, and fat in plate waste increased with fat in the served cooked beef. The amounts of beef in plate waste were not always significantly correlated with the amounts of raw beef issued; however, the percentages of fat in the plate waste were significantly correlated with the percentages of fat in the cooked beef. It was calculated that 67 percent of the food energy of the issued beef, 84 percent of the protein, and 51 percent of the fat were eaten; 10, 6, and 11 percent of the issued beef food energy, protein, and fat, respectively, appeared in the plate waste. It was also calculated that 7 percent of the food energy, 9 percent of the protein, and 6 percent of the fat in the issued beef were left as unserved edible beef at the serving table.

## Introduction

The meat servings in the feeding programs of the Armed Services furnish a large part of the required protein and fat and hence of the total food energy provided by the diet. To an increasing extent, beef procurement is shifting from carcass beef toward frozen boneless beef which offers advantages in handling and transportation.

Available data on the nutritive value of the various cuts of carcass beef are not applicable to the cuts and forms of boneless beef. This study was planned, therefore, to obtain composition data directly on 4-way boneless beef, cut and packed according to United States Army specifications. Analyses were made on raw beef as issued and as cooked by Army personnel with Army equipment.

While the cuts made to meet Army specifications for boneless beef are not necessarily identical with those in civilian markets, the data reported here are applicable to household and institutional use. Restaurants, hospitals, and other institutions feeding large numbers of people use considerable quantities of boneless beef. Furthermore, the present study provides data which permit relating the nutritive value of boneless beef to carcass beef.

The studies here reported were carried out during 1951-53. In 1951, boneless beef was obtained from eight representative carcasses of Army grade B (equivalent to U. S. Choice). The yields of cuts and forms of boneless beef, fat trim, waste trim, and bones were obtained from these carcasses. The cuts from one side of the carcass were analyzed raw for comparison with cuts from the other side after they were cooked according to standardized procedures and recipes. The whole of the raw beef cut and of the cooked beef cut was taken for the sample to be analyzed.

Because plate waste is a problem of those responsible for the feeding of Army personnel, a special study of plate waste from oven roasts was made during the first year. This included observations of the effect of trimming surface fat to  $\frac{1}{4}$  inch before cooking on the amount of fat appearing in plate waste. Fat discarded as waste from the table has taken up valuable freezing space and otherwise added to the costs of beef handling. Since fat is an important source of food energy, plate

waste could account for much of the difference between the number of calories planned and issued per man and the number in the food eaten.

During the second year, 1952-53, composition data were obtained on boneless beef as actually issued, cooked, and served in Army messes. The 52,682 pounds of boneless beef used from 560,000 pounds made available at the time of the study represented actual Army supply from 6 different processors of boneless beef in different areas. The 542 company mess meals were served to 109,128 men in 5 locations. The large-scale operation involved carloads of beef and thousands of men and was planned in great detail in order to determine not only the amounts and composition of the beef served but also the amounts of protein, fat, and food energy in the portion eaten.

## PART I

### Carcass Yields and Composition of Cuts and Forms of 4-Way Boneless Beef, Cooked by Army Procedures and Standardized Recipes

#### Cuts and Forms of 4-Way Boneless Beef

Beef cut according to military specifications is known as 4-way beef, so called because the carcass is processed to provide boneless cuts and forms for 4 different types of cooked beef—roasts or steaks cooked by dry heat, roasts or steaks cooked by moist heat, meat for stews, and meat for such dishes as meat loaves and hamburgers. The cuts and forms comprise the following:

1. Seven cuts designated for oven roasts or for griddle-broiled steaks, usually called "Roasts or steaks (dry heat)":
 

Blade roll	Sirloin butt
Inside of round	Spencer roll
Knuckle of round	Tenderloin
Loin strip	
2. Five cuts designated for pot roasts or for Swiss steaks, usually called "Roasts or steaks (moist heat)":
 

Chuck roll	Outside of round
Chuck tender	Rump butt
Clod	
3. Diced beef designated for stew
4. Ground beef designated for meat loaves, hamburgers, "beef-burger" (see p. 21), and other similar preparations.

From standardized inspection procedures for 4-way boneless beef (6)<sup>2</sup> and from published information on the cuts of carcass beef more familiar to the civilian population (8), a chart (fig. 1) has been prepared to show the comparative sources of cuts.

<sup>2</sup> Italic numbers in parentheses refer to Literature Cited, p. 32.



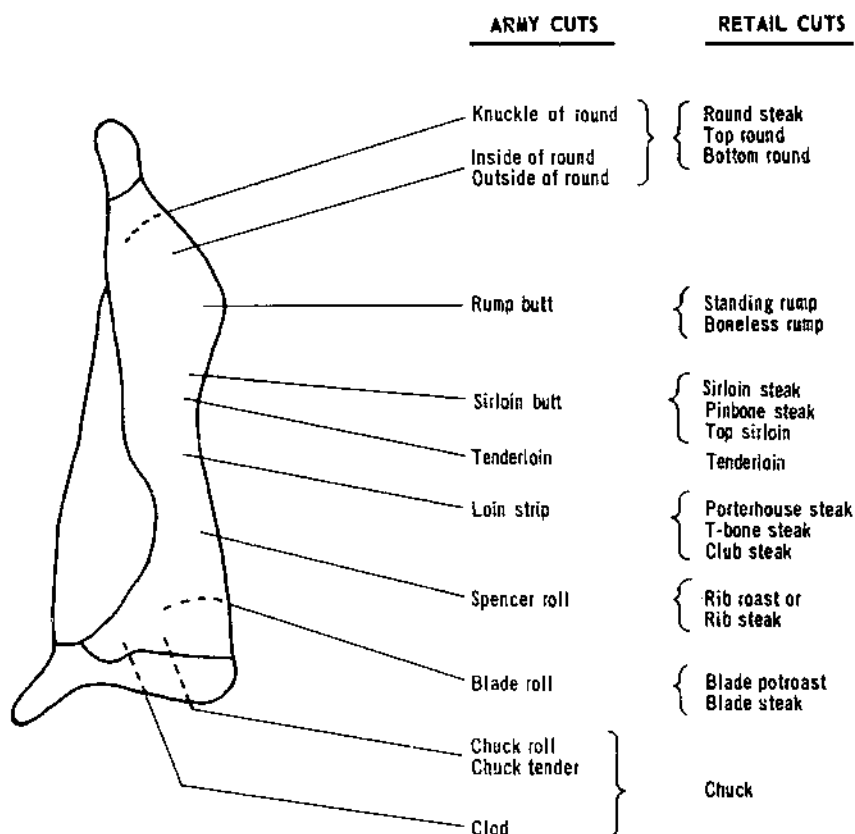


FIGURE 1.—Carcass location of Army boneless beef cuts and of retail beef cuts.

### Procedures

The source of beef used in part I of the study consisted of eight carcasses of grade B, selected and graded by representatives in Chicago of the Veterinary Division, Office of The Surgeon General, at the plant of a large commercial packer.

Weights of carcasses and weights and identity of all forms and cuts of boneless beef and other parts were recorded by carcass number and side during the carcass cutting. The beef was wrapped and boxed for freezing and subsequent shipping to Fort Lee, Va., where the cooking was done with equipment made available by the Army and according to procedures and recipes given in the Army and Air Force manual on recipes (5).

In order to control sampling of beef used for analysis, plans were made to take a cut from one side as the raw sample and the corresponding cut of the same carcass from the other side for the sample to be cooked. The distribution plan is given (table 1). For the cuts designated roasts or steaks, 4 carcasses, selected at random, were used for roasts while the remaining 4 were used for steaks.

TABLE 1.—Assignment of matched cuts and forms of 4-way boneless beef by carcass number and side

Cut or form of beef	Carcass number and side <sup>1</sup>	
	Raw sample	Sample to be cooked
Beef cuts:		
Oven roasts.....	5R, 6L, 7I, 8R	5L, 6R, 7R, 8L
Pot roast.....	5R, 6L, 7L, 8R	5L, 6R, 7R, 8L
Griddle-broiled steaks.....	1L, 2R, 3L, 4R	1R, 2L, 3R, 4L
Swiss steaks.....	1L, 2R, 3L, 4R	1R, 2L, 3R, 4L
Diced beef:		
Stew.....	1L, 2R, 3L, 4R, 5R, 6L, 7L, 8R	1R, 2L, 3R, 4L, 5L, 6R, 7R, 8L
Ground beef:		
Hamburger.....	1R, 1L, 2R, 2L, 3R, 3L, 4R, 4L	1R, 1L, 2R, 2L, 3R, 3L, 4R, 4L
Meat loaf.....	5R, 5L, 6R, 6L, 7R, 7L, 8R, 8L	5R, 5L, 6R, 6L, 7R, 7L, 8R, 8L

<sup>1</sup> "R" and "L" signify "right" and "left," respectively.

To obtain comparable data on raw and cooked roasts and steaks, the usual Army cooking procedures were slightly modified. Roasts were placed in individual pans, and steaks were broiled on a griddle without added fat; steaks broiled at any one time were from the same cut. The ground beef from 4 of the 8 carcasses was taken for hamburgers while the ground beef from the other 4 was used for meat loaves. The ground beef from each half carcass was divided into thirds—one-third for the raw ground beef sample, one-third for the raw-recipe sample including all ingredients, and one-third for the cooked recipe. The diced beef from all 8 carcasses was used for stew.

Recipe ingredients were analyzed separately in order that their contributions toward the total protein, fat, and food energy of the finished dish could be obtained. Recipe ingredients given (5) were used in the weight percentages summarized (table 2). Recipes were standardized as to the proportion of ingredients.

TABLE 2.—Ingredients in percentages of weight of beef recipe

Ingredient	Pot roast	Swiss steak	Stew	Hamburger	Meat loaf
	Percent	Percent	Percent	Percent	Percent
Beef, boneless, frozen.....	54.6	62.4	32.0	67.2	72.5
Bread crumbs, dry.....				11.0	7.1
Carrots, cooked, canned (drained).....	10.0		0.3		
Celery.....	4.0				7.1
Eggs.....					12.0
Fat.....	1.3	3.0	1.8		
Flour.....		4.5	2.9		
Milk, evaporated.....				0.0	
Onions, dehydrated.....	.7	.9	.9	1.1	.7
Peas, frozen.....			5.8		
Tomatoes, canned.....		20.3	7.0		
Water.....	28.9	( <sup>2</sup> )	30.2	14.7	

<sup>1</sup> Purced before adding to recipe.

<sup>2</sup> Varying amounts used to make gravy.

In the roast and steak samples taken for analysis, the lean and the fat portions were separated; these were ground and analyzed separately. In handling gravies and liquids, the procedures were adapted to the problems of sampling. If fat layers or suspended solids could be

easily removed from the gravies or liquid portions of the cooked recipe, they were analyzed separately and the data recombined. In any case, the whole portion taken for analysis was ground or mixed for subsampling. From one cut, for example, all the raw lean was ground and a record kept of weights so that recoveries from such operations would be quantitative.

Each subsample was placed in an enamelware tray under infrared lamps for preliminary drying (3). All dried materials were ground in a laboratory Wiley mill to pass 20 mesh. Fatty samples difficult to grind were first extracted with ethyl ether in Soxhlet extractors.

The ground samples were analyzed, as required, according to the following procedures:

For residual moisture, by drying the sample in a vacuum oven at 70° C. and less than 25 mm. of mercury.

For residual moisture and fat, by extracting the sample in a Selas (or equivalent) crucible in a Bailey-Walker extractor, and then weighing the material in the crucible both before and after extraction, and also weighing the extracted fat.

For fat, by using either the Soxhlet apparatus (1, p. 359) or the Bailey-Walker extractor.

For nitrogen, by the Kjeldahl procedure (1, p. 12).

For total ash, by the method described by Linnig and associates (4).

Protein was calculated on the basis of  $N \times 6.25$ ; and total carbohydrate was obtained by calculating the difference between 100 percent and the sum of the percentages of moisture, protein, fat, and total ash contents. Physiological energy values for raw beef and for roasts and steaks were obtained by using the factors 9.02 calories per gram of fat and 4.27 calories per gram of protein. The factors (7) used for the other cooked items depended upon the ingredients in the recipe; they are summarized in table 3.

TABLE 3.—Factors for calculating physiological energy values for beef recipes

Recipe	Protein	Fat	Total carbo- hydrate
Pot roast.....	4.24	9.02	3.81
Swiss steak.....	4.23	9.02	3.97
Stew.....	4.18	9.01	4.02
Hamburger.....	4.23	9.00	4.08
Meat loaf.....	4.25	9.01	4.06

## Results

### Carcass Yields of 4-Way Boneless Beef

The 8 carcasses ranged in weight from 605 to 727 pounds and averaged 682 pounds. The yields of cuts and forms of boneless beef amounted to 66 percent of the carcass weight. The average weights of the individual cuts and the average percentage yields with their standard deviations are given (table 4), together with fat trimmings, waste trimmings, bones, kidney, and kidney fat. Standard deviation in each case represents the variation shown by 8 items from 8 carcasses, including the percentage yields. Fat trimmings (14 percent)

and bones (15 percent) made up most of the carcass other than boneless beef.

These yields of boneless beef compared well with those reported by Graf who reported the yield of boneless beef to be 68 percent of the carcass weight based on a study made in 1949 (2) and on 1951-52 data from large-scale procurement of boneless beef (personal communication from R. L. Graf). (See table 5.)

#### Cooked Yields

To prepare the boneless beef for cooking, the cuts were thawed; the thaw juices yielded were not used in cooking any of this beef. These juices amounted to 4.5 percent of the raw frozen weight of the cuts assigned to oven roasts or griddle-broiled steaks, 3.8 percent of those assigned to pot roasts or Swiss steaks, 5.0 percent of the diced meat, and 3.4 percent of the ground meat. The average for all cuts and forms was 4.2 percent.

TABLE 4.—Average weights and percentage yield of cuts and forms of 4-way boneless beef and other items from 8 beef carcasses of Army grade B or U. S. Choice

Item	Weight								Yield	
	Left side		Right side		Total carcass				Percent of total carcass	Standard deviation
	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation		
	Kilograms	Kilograms	Kilograms	Kilograms	Kilograms	Kilograms	Pounds	Pounds		
Roasts or steaks (dry heat)	32.134	2.917	31.922	3.117	64.056	5.989	141.22	13.20	20.72	0.93
Blade roll.....	1.644	.210	1.616	.208	3.260	.392	7.19	.86	1.05	.06
Inside of round.....	7.442	.720	7.498	.660	14.940	1.340	32.94	2.95	4.84	.24
Knuckle of round.....	4.130	.525	4.366	.462	8.505	.204	18.75	.65	2.75	.15
Loin strip.....	5.103	.598	4.820	.722	9.922	1.230	21.87	2.71	3.21	.32
Sirloin butt.....	6.691	.644	6.152	.761	12.843	1.364	28.31	3.01	4.16	.31
Spencer roll.....	4.493	.570	4.706	.555	9.200	.972	20.28	2.14	2.97	.13
Tenderloin.....	2.622	.246	2.764	.420	5.386	.621	11.87	1.37	1.74	.16
Roasts or steaks (moist heat)	21.240	2.158	21.829	1.851	43.078	3.998	94.97	8.81	13.93	.37
Clod.....	7.229	.548	7.285	.406	14.515	.927	32.00	2.72	4.70	.20
Chuck roll.....	4.905	.737	5.174	.528	10.079	1.236	22.22	2.04	3.26	.16
Chuck tender.....	1.148	.154	1.120	.205	2.268	.348	5.00	.77	3.71	.02
Outside of round.....	5.713	.740	5.783	.712	11.496	1.439	25.34	3.17	3.71	.26
Rump butt.....	2.254	.331	2.465	.342	4.720	.624	10.41	1.38	1.53	.16
Diced beef.....	12.757	1.079	12.488	1.861	25.245	2.410	55.66	5.31	8.17	.45
Forequarter.....	9.008	.261	9.682	1.756	19.590	2.007	43.19	4.62	6.34	.44
Hindquarter.....	2.849	.311	2.806	.505	5.655	.515	12.47	1.14	1.83	.12
Ground beef.....	36.132	2.809	36.061	2.910	72.193	5.320	159.16	11.73	23.37	.48
Forequarter.....	24.863	2.111	24.778	2.252	49.641	3.712	109.44	8.18	16.08	.62
Hindquarter.....	11.260	.866	11.283	1.245	22.552	2.080	49.72	4.59	7.29	.30
Fat trimmings.....	21.759	2.710	21.830	1.757	43.589	5.847	96.10	12.89	14.06	1.06
Forequarter.....	9.826	1.355	9.625	1.097	19.491	2.415	42.97	5.32	6.29	.44
Hindquarter.....	11.893	1.495	12.205	2.182	24.098	3.644	53.13	8.03	7.77	.75
Waste trimmings.....	3.700	.538	3.827	.506	7.527	.827	16.59	1.82	2.45	.33
Forequarter.....	1.446	.205	1.432	.378	2.878	.445	6.34	.95	.94	.18
Hindquarter.....	2.254	.381	2.395	.312	4.649	.500	10.25	1.10	1.51	.17
Bones.....	23.572	1.669	22.553	1.997	46.125	2.992	101.69	6.60	14.95	.50
Forequarter.....	13.891	1.108	13.240	1.001	27.131	2.063	59.81	4.55	8.79	.33
Hindquarter.....	9.681	.630	9.313	.523	18.994	1.052	41.88	2.32	6.16	.26
Kidney.....	.430	.041	.439	.041	.878	.080	1.94	.18	.29	.02
Kidney fat.....	2.991	.998	2.155	.917	5.146	1.895	11.34	4.18	1.64	.53
Hanging tender.....					1.318	.200	2.91	.44	.42	.05
Total of 10 main items.....	154.733		153.104		309.155		681.58		100.02	

TABLE 5.—Percentage yields and distribution of boneless cuts and forms of beef<sup>1</sup>

Cut or form of beef	Percentage of carcass	Percentage of type of beef	Cut or form of beef	Percentage of carcass	Percentage of type of beef
Roasts or steaks (dry heat).....	22.064	100.05	Roasts or steaks (moist heat)...	13.592	99.97
Blade roll.....	1.082	4.91	Clod.....	4.417	32.49
Inside of round.....	5.741	26.03	Chuck roll.....	3.620	26.62
Knuckle of round.....	2.990	13.56	Chuck tender.....	.821	6.04
Loin strip.....	3.240	14.69	Outside of round.....	2.827	20.80
Sirloin butt.....	4.085	18.53	Rump butt.....	1.967	14.02
Spencer roll.....	2.910	13.19	Diced beef.....	8.437	.....
Tenderloin.....	2.016	9.14	Ground beef.....	23.915	.....

<sup>1</sup> From carcass-cutting data (2), and from unpublished 1951-52 data on larger-scale procurement of boneless beef for the Armed Services (personal communication from R. L. Graf).

Yields of drained cooked beef (table 6) from the raw frozen beef were 64 percent for oven roasts, 66 percent for pot roasts, 67 percent for griddle-broiled steaks, and 77 percent for Swiss steaks. Where there were ingredients, the cooked-recipe yield from the raw recipe (beef

TABLE 6.—Average weights of raw and cooked items and yields of cooked beef or beef recipe

Type of beef or beef recipe	Weight before cooking				Weight after cooking			Yield of cooked beef	
	Frozen beef	Thaw juices	Drained thawed beef	Raw recipe with ingredients	Drippings	Scrappings	Drained cooked beef	From raw recipe	
								From raw recipe	From frozen beef
	Kilo-grams	Kilo-grams	Kilo-grams	Kilo-grams	Kilo-grams	Kilo-grams	Percent	Percent	
Oven roasts.....	30.672	1.316	20.359	.....	1.932	0.414	19.553	66.6	63.7
Blade roll.....	1.670	.066	1.604	.....	.062	.028	1.148	71.6	68.7
Inside of round.....	7.385	.219	7.168	.....	.320	.132	4.568	63.7	61.8
Knuckle of round.....	4.066	.315	3.771	.....	.086	.057	2.463	65.3	64.3
Loin strip.....	4.632	.186	4.466	.....	.357	.048	3.132	70.1	67.3
Sirloin butt.....	6.162	.320	5.842	.....	.529	.060	3.874	66.3	62.0
Spencer roll.....	4.300	.132	4.174	.....	.385	.056	2.794	66.9	64.0
Tenderloin.....	2.411	.078	2.333	.....	.193	.033	1.574	67.5	65.3
Griddle-broiled steaks.....	32.368	1.409	30.726	.....	.368	.406	21.770	70.8	67.3
Blade roll.....	1.538	.026	1.492	.....	.022	.008	1.060	71.0	68.9
Inside of round.....	7.388	.506	6.861	.....	.047	.149	4.710	68.0	63.8
Knuckle of round.....	4.147	.258	3.860	.....	.064	.049	2.558	66.3	61.7
Loin strip.....	5.074	.220	4.837	.....	.050	.066	3.495	72.3	68.9
Sirloin butt.....	6.665	.329	6.320	.....	.072	.063	4.614	73.0	69.2
Spencer roll.....	4.735	.096	4.611	.....	.069	.057	3.381	73.3	71.4
Tenderloin.....	2.825	.064	2.745	.....	.047	.032	1.982	71.1	69.1
Pot roasts.....	21.460	.089	20.472	38.328	11.414	.....	14.097	36.8	65.7
Clod.....	7.150	.334	6.822	12.078	3.539	.....	5.132	42.5	71.7
Chuck roll.....	5.086	.257	4.829	8.960	2.641	.....	3.095	34.6	60.9
Chuck tender.....	1.074	.043	1.026	2.483	1.898	.....	.631	25.4	58.8
Outside of round.....	5.777	.200	5.577	9.580	2.576	.....	3.710	38.6	64.3
Rump butt.....	2.307	.149	2.218	5.227	1.700	.....	1.520	20.1	64.2
Swiss steaks.....	20.784	.630	20.148	41.416	17.417	.....	16.044	38.7	77.2
Clod.....	7.202	.218	6.984	13.336	4.816	.....	3.542	43.8	81.1
Chuck roll.....	4.776	.165	4.611	8.829	3.948	.....	3.064	41.8	75.5
Chuck tender.....	1.144	.029	1.115	3.109	1.504	.....	.747	24.0	46.3
Outside of round.....	5.474	.138	5.336	11.659	5.299	.....	4.104	35.2	75.0
Rump butt.....	2.188	.080	2.102	4.683	1.680	.....	1.747	37.3	79.8
Slow:									
Diced beef.....	12.788	.762	12.026	38.477	.....	.130	32.471	84.4	.....
Hamburger:									
Ground meat.....	11.051	.342	10.727	16.148	.346	.140	13.466	83.4	.....
Meat loaf:									
Ground meat.....	11.094	.436	10.658	14.968	.503	.366	12.172	81.3	.....

<sup>1</sup> Includes liquids and vegetables.

<sup>2</sup> Includes recipe ingredients.

plus ingredients) was 84 percent for stew including the liquids and vegetables, 83 percent for hamburgers, and 81 percent for meat loaves, which included the ingredients but did not include the drippings. Pan drippings amounted to 3.6 percent and pan scrapings to 1.3 percent of the raw frozen beef designated for oven roasts and griddle-broiled steaks.

### Composition of Raw and Cooked Boneless Beef

The moisture, food energy, protein, fat, total carbohydrate, and total ash of the individual raw boneless beef cuts and forms and of the cooked beef or beef recipe are given (table 7). Weighted-average values for food energy, protein, and fat are summarized (table 8). The weighting of averages was necessary so that the composition data would represent the whole group of roasts; for example, the boneless beef of inside of round would represent more than four times that of the blade roll (table 4).

TABLE 7.—Average composition and energy value per 100 grams of cuts and forms of 4-way boneless beef, raw and cooked, and drippings

Item	Water	Food energy	Protein (N×6.25)	Fat	Total carbohydrate	Ash
	Grams	Calories	Grams	Grams	Grams	Grams
Oven roasts:						
Blade roll:						
Raw frozen beef.....	61.2	264	18.4	20.6	.....	0.8
Cooked drained beef.....	48.8	328	24.2	25.0	.....	1.3
Drippings.....	31.1	499	11.0	50.1	.....	1.5
Inside of round:						
Raw frozen beef.....	65.4	217	19.7	14.7	.....	1.0
Cooked drained beef.....	50.8	291	29.3	18.4	.....	1.4
Drippings.....	27.3	542	7.4	56.6	.....	2.4
Knuckle of round:						
Raw frozen beef.....	70.8	154	19.8	7.7	.....	1.0
Cooked drained beef.....	56.6	225	30.4	16.6	.....	1.2
Drippings.....	28.0	502	13.6	49.3	.....	5.2
Loin strip:						
Raw frozen beef.....	54.3	320	17.4	27.3	.....	.8
Cooked drained beef.....	41.7	404	23.6	33.6	.....	1.0
Drippings.....	27.7	586	5.3	62.5	.....	1.6
Sirloin butt:						
Raw frozen beef.....	57.3	294	17.1	24.5	.....	.8
Cooked drained beef.....	43.1	381	23.7	31.0	.....	1.2
Drippings.....	18.5	681	4.5	73.4	.....	1.4
Sp. acer roll:						
Raw frozen beef.....	40.3	375	15.1	34.4	.....	.7
Cooked drained beef.....	37.1	443	22.1	38.6	.....	.8
Drippings.....	10.4	766	2.2	84.0	.....	.8
Tenderloin:						
Raw frozen beef.....	55.4	316	16.2	27.4	.....	.8
Cooked drained beef.....	46.0	351	23.6	27.6	.....	1.2
Drippings.....	15.5	719	2.7	78.4	.....	1.0
Pot roasts:						
Clod:						
Raw frozen beef.....	60.3	265	17.5	21.1	.....	.8
Cooked drained beef.....	48.6	341	23.4	26.8	.....	1.2
Vegetables and juices.....	80.2	132	2.4	11.3	5.0	1.0
Chuck roll:						
Raw frozen beef.....	65.4	213	18.7	14.8	.....	.8
Cooked drained beef.....	52.4	291	28.4	17.8	.....	1.0
Vegetables and juices.....	79.7	138	3.0	12.0	4.3	.9
Chuck tender:						
Raw frozen beef.....	72.1	152	18.2	8.2	.....	1.0
Cooked drained beef.....	58.4	237	31.4	11.5	.....	1.5
Vegetables and juices.....	89.0	50	2.0	4.0	3.3	.9
Outside of round:						
Raw frozen beef.....	62.4	242	19.0	17.3	.....	.8
Cooked drained beef.....	53.0	289	27.4	19.2	.....	1.0
Vegetables and juices.....	71.4	199	3.8	17.8	5.6	1.3

TABLE 7.—Average composition and energy value per 100 grams of cuts and forms of 4-way boneless beef, raw and cooked, and drippings—Continued

Item	Water	Food energy	Protein (N×6.25)	Fat	Total carbohydrate	Ash
Pot roasts—Continued						
Rump butt:	Grams	Calories	Grams	Grams	Grams	Grams
Raw frozen beef.....	57.6	300	17.6	24.9	.....	.8
Cooked drained beef.....	43.7	385	23.5	31.6	.....	.8
Vegetables and juices.....	81.1	138	1.6	13.1	3.4	.7
Griddle-broiled steaks:						
Blade roll:						
Raw frozen beef.....	58.2	275	17.7	22.1	.....	.8
Cooked drained beef.....	42.7	306	22.4	33.3	.....	.9
Drippings.....	65.5	234	7.3	22.5	.....	2.2
Inside of round:						
Raw frozen beef.....	65.4	210	19.3	14.1	.....	.9
Cooked drained beef.....	51.4	206	26.8	20.1	.....	1.1
Drippings.....	83.8	41	7.8	.0	.....	2.7
Knuckle of round:						
Raw frozen beef.....	69.8	169	19.6	9.5	.....	.9
Cooked drained beef.....	56.2	244	28.4	13.5	.....	1.2
Drippings.....	84.4	52	8.7	1.7	.....	3.0
Loin strip:						
Raw frozen beef.....	52.3	343	16.2	30.4	.....	.8
Cooked drained beef.....	37.4	452	20.8	40.2	.....	.8
Drippings.....	16.7	735	3.0	86.1	.....	.6
Spencer roll:						
Raw frozen beef.....	56.6	400	14.8	37.4	.....	.6
Cooked drained beef.....	34.4	494	17.8	46.4	.....	.8
Drippings.....	14.2	760	1.3	83.6	.....	.4
Tenderloin:						
Raw frozen beef.....	55.4	314	15.6	27.4	.....	.9
Cooked drained beef.....	42.8	389	22.1	32.6	.....	.9
Drippings.....	35.0	543	2.5	59.0	.....	1.0
Swiss steaks:						
Clod:						
Raw frozen beef.....	69.2	204	18.0	20.8	.....	.8
Cooked drained beef.....	53.0	305	19.4	23.0	3.9	.7
Vegetables and juices.....	72.1	183	4.0	14.7	8.3	.8
Chuck roll:						
Raw frozen beef.....	65.3	219	17.9	15.8	.....	.8
Cooked drained beef.....	58.7	245	22.4	15.7	2.4	.8
Vegetables and juices.....	72.8	182	3.6	15.0	7.8	.8
Chuck tender:						
Raw frozen beef.....	71.6	153	19.0	9.0	.....	1.0
Cooked drained beef.....	70.0	215	26.6	10.6	1.8	.8
Vegetables and juices.....	83.0	108	2.2	8.1	5.4	.8
Outside of round:						
Raw frozen beef.....	62.2	244	17.5	18.8	.....	1.0
Cooked drained beef.....	54.3	286	21.8	20.2	3.1	.6
Vegetables and juices.....	78.8	131	3.2	9.8	7.5	.8
Rump butt:						
Raw frozen beef.....	55.9	312	15.5	27.3	.....	.7
Cooked drained beef.....	49.2	352	18.3	29.2	2.6	.7
Vegetables and juices.....	77.0	150	2.8	12.0	7.4	.8
Diced beef:						
Raw frozen beef.....	59.3	273	17.1	22.2	.....	.8
Raw recipe ingredients (other than beef and water).....	74.2	.....	3.1	6.2	15.9	.5
Cooked recipe, stew.....	75.2	155	7.5	11.2	5.6	.6
Ground beef:						
Hamburger:						
Raw frozen beef.....	53.0	291	16.4	24.5	.....	.7
Raw recipe (total).....	60.2	252	13.0	18.6	7.3	.8
Cooked recipe.....	54.8	280	17.9	19.5	6.9	1.0
Drippings.....	1.6	882	.....	98.0	.....	0
Meat loaf:						
Raw frozen beef.....	58.2	291	16.4	24.5	.....	.7
Raw recipe (total).....	59.0	265	14.5	20.0	5.7	.8
Cooked recipe.....	54.8	280	17.9	19.5	6.9	1.0
Drippings.....	6.6	824	1.2	96.9	.....	.1



TABLE 8.—*Weighted-average values for food energy, protein, and fat per 100 grams of different cuts and forms of beef or recipe, raw and cooked*

Cut or form of beef	Raw			Cooked †		
	Food energy	Protein	Fat	Food energy	Protein	Fat
<i>Beef cuts:</i>	<i>Calories</i>	<i>Grams</i>	<i>Grams</i>	<i>Calories</i>	<i>Grams</i>	<i>Grams</i>
Oven roasts.....	274	17.8	21.9	346	25.7	20.2
Pot roasts.....	249	18.2	18.5	312	26.1	22.4
Griddle-broiled steaks.....	283	17.1	23.3	379	22.9	31.1
Swiss steaks.....	247	17.6	19.1	287	21.0	20.6
<i>Diced beef:</i>						
Stew (total).....	273	17.1	22.2	154	7.4	11.8
<i>Ground beef:</i>						
Hamburger.....	291	15.8	24.8	263	15.6	17.7
Meat loaf.....	291	16.4	24.5	280	17.9	19.5

† Drained solids except for stew.

The distribution of protein and fat among thaw juices, pan drippings, and cooked beef is shown (table 9). The pan scrapings were small in amount and often provided an insufficient sample for the analyses. The thaw juices contained no measurable quantity of fat and relatively small amounts of protein—only 2.3 percent of the total protein in the raw beef. Over 95 percent of the protein was found in the cooked oven roasts, griddle-broiled steaks, stew, hamburgers, and meat loaves. The amount of fat in drippings was variable, depending on cooking method and recipe. Over 20 percent of the fat was found in drippings from oven roasts, whereas the same cuts cooked as griddle-broiled steaks contributed only 4 percent of fat to the drippings. Cuts cooked as pot roasts and Swiss steaks contributed, respectively, 31 and 39 percent of their fat content to drippings; hamburger and meat loaf contributed 18 and 12 percent.

TABLE 9.—*Distribution of protein and fat among thaw juices, drippings, and cooked items from various cuts and forms of beef*

Cut or form of beef	Protein			Fat		
	Thaw juices	Drippings	Cooked beef or recipe	Thaw juices	Drippings	Cooked beef or recipe
<i>Beef cuts:</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>
Oven roasts.....	2.6	1.8	95.6	.....	20.6	79.4
Pot roasts.....	2.5	7.6	89.9	.....	31.1	68.9
Griddle-broiled steaks.....	3.0	.4	96.6	.....	4.2	95.8
Swiss steaks.....	1.6	14.7	83.7	.....	39.2	60.8
<i>Diced beef:</i>						
Stew.....	3.1	.....	96.9	.....	.....	100.0
<i>Ground beef:</i>						
Hamburger.....	2.4	.4	97.2	.....	18.2	81.8
Meat loaf.....	1.4	0	98.6	.....	12.6	87.4

The composition data make it possible to calculate, on a carcass basis, the yield of food energy, protein, and fat in the cooked beef. The data in table 10 show the contributions of the beef only toward the food energy, protein, and fat in the cooked beef or cooked-beef recipe. For example, 21.9 gram of fat in 100 grams of raw frozen oven roast (table 8) were calculated to contribute 16.7 grams of fat

in the corresponding 63.7 grams of cooked oven roast (table 6). For hamburgers, calculations took account of the ingredients, so that 15.8 grams of protein in 100 grams of raw frozen ground beef were calculated to contribute 15.5 grams of protein in the corresponding 122 grams of cooked hamburger recipe.

TABLE 10.—Weighted-average values for food energy, protein, and fat contributed per 100 grams of raw frozen beef to the cooked beef or cooked beef recipe

Cut or form of beef	Food energy	Protein	Fat
	Calories	Grams	Grams
Beef cuts:			
Oven roasts.....	220	16.4	16.7
Pot roasts.....	206	17.1	14.7
Griddle-broiled steaks.....	255	15.4	20.9
Swiss steaks.....	212	16.2	15.0
Diced beef:			
Stew.....	271	16.5	22.2
Ground beef:			
Hamburger.....	238	15.5	19.1
Meat loaf.....	230	15.8	18.7

From the data in table 10, together with data on average carcass weight and yields (table 4) and average food energy, protein, and fat content of the frozen raw beef (table 8), composition data on a carcass basis were calculated (table 11). The amount of cuts designated for roasts and steaks was assumed to be equally divided for oven roasts and griddle-broiled steaks and for pot roasts and Swiss steaks. The ground meat was assumed to be equally divided for hamburgers and meat loaves. Food-energy yield in the cooked beef amounted to 85 percent of the food energy in the raw boneless beef; protein, 94 percent; fat, 82 percent.

TABLE 11.—Calculated food energy, protein, and fat in the raw boneless beef in the average of 8 carcasses (309.155 kilograms) and in the corresponding cooked drained cuts of beef or beef recipe

Cut or form of beef	Raw			Cooked		
	Food energy	Protein	Fat	Food energy	Protein	Fat
Beef cuts:	Calories	Grams	Grams	Calories	Grams	Grams
Oven roasts.....	87,757	5,704	7,014	70,462	5,252	5,389
Pot roasts.....	53,632	3,920	3,985	44,357	3,682	3,165
Griddle-broiled steaks.....	90,639	5,477	7,462	81,672	4,932	6,894
Swiss steaks.....	53,201	3,791	4,114	45,049	3,488	3,424
Diced beef:						
Stew.....	98,919	4,317	5,604	68,449	4,168	5,607
Ground beef:						
Hamburger.....	105,030	5,703	8,952	85,940	5,507	6,897
Meat loaf.....	105,030	5,920	8,844	85,218	5,705	6,752
Total.....	564,226	34,829	45,975	481,748	32,824	37,938

### Percentages of Lean and of Separable Fat

Composition data obtained from the laboratory analyses of the separable lean and fat from 12 cuts of boneless beef are shown by cut (raw and cooked) in table 12 and are summarized in table 13. As would be expected, since both fat and lean cuts were represented, the

yields of lean beef varied with the cut. Spencer roll, for example, was a fat cut and had only 68 percent of separable lean as compared with knuckle of round which had 95 percent. Cooking of the beef resulted in moisture loss in the lean and fat loss in the separable fat.

TABLE 12.—Average separable lean per 100 grams roasts and steaks and average composition of 100 grams separable lean and separable fat

Type of roast or steak	Weight of separable lean	Composition of separable lean			Composition of separable fat		
		Water	Protein	Fat	Water	Protein	Fat
Oven roasts:							
Blade roll:							
Raw frozen.....	80.1	68.2	20.6	16.2	17.1	5.7	76.0
Cooked.....	84.8	54.1	27.9	16.1	17.0	4.7	76.0
Inside of round:							
Raw frozen.....	85.2	72.6	22.8	3.9	17.8	4.9	77.0
Cooked.....	80.4	56.2	32.9	9.0	18.1	7.4	73.9
Knuckle of round:							
Raw frozen.....	95.2	72.9	20.3	5.1	29.4	0.0	61.2
Cooked.....	96.7	57.4	31.3	8.9	23.2	8.7	65.8
Loin strip:							
Raw frozen.....	74.8	68.6	22.0	8.5	12.1	4.4	83.2
Cooked.....	72.1	53.0	31.2	14.6	11.1	4.8	83.4
Sirloin butt:							
Raw frozen.....	75.4	71.1	21.2	6.4	14.9	4.6	80.4
Cooked.....	73.0	53.6	28.6	12.6	13.6	4.4	81.2
Spencer roll:							
Raw frozen.....	67.6	68.3	20.9	9.2	9.8	3.0	86.9
Cooked.....	67.6	48.9	31.1	17.1	11.8	4.0	83.7
Tenderloin:							
Raw frozen.....	72.6	70.4	20.8	7.4	15.6	4.1	80.2
Cooked.....	70.1	54.1	29.0	8.8	12.2	4.7	82.5
Pot roasts:							
Clod:							
Raw frozen.....	80.4	71.0	20.6	7.3	17.2	5.0	77.6
Cooked.....	75.8	57.6	29.0	12.2	20.8	7.3	71.4
Chuck roll:							
Raw frozen.....	89.2	70.8	20.2	7.8	21.2	6.4	72.1
Cooked.....	89.2	54.8	30.5	13.2	31.4	11.4	50.9
Chuck tender:							
Raw frozen.....	92.9	75.1	18.7	4.5	32.9	10.6	56.1
Cooked.....	93.6	58.2	32.0	8.6	21.9	9.4	68.2
Outside of round:							
Raw frozen.....	82.4	76.5	21.6	5.8	19.8	6.7	73.3
Cooked.....	84.3	57.9	31.2	10.4	26.5	8.7	64.4
Rump butt:							
Raw frozen.....	75.0	70.7	20.2	7.8	18.2	5.3	76.1
Cooked.....	71.1	54.2	30.9	13.3	18.2	5.8	75.6
Griddle-broiled steaks:							
Blade roll:							
Raw frozen.....	84.1	67.0	20.2	11.2	15.4	5.0	79.2
Cooked.....	78.9	49.2	26.7	22.4	17.8	0.0	74.7
Inside of round:							
Raw frozen.....	86.3	73.1	21.2	4.4	17.5	6.8	75.4
Cooked.....	79.8	58.3	32.0	8.0	24.0	6.6	68.5
Knuckle of round:							
Raw frozen.....	93.8	72.6	20.4	5.9	29.0	7.7	62.9
Cooked.....	91.4	58.7	30.3	8.9	29.1	8.0	61.6
Loin strip:							
Raw frozen.....	70.0	69.2	20.3	8.0	12.8	6.6	80.5
Cooked.....	69.7	51.0	30.8	16.1	16.6	5.6	77.0
Sirloin butt:							
Raw frozen.....	75.0	71.0	19.8	7.2	13.5	3.8	82.4
Cooked.....	62.5	55.1	30.0	12.3	17.6	5.0	76.7
Spencer roll:							
Raw frozen.....	64.1	66.0	21.2	10.5	10.7	3.3	85.7
Cooked.....	53.2	56.0	25.9	18.5	16.1	5.0	78.2
Tenderloin:							
Raw frozen.....	72.2	69.8	19.7	8.4	17.8	5.0	77.0
Cooked.....	67.7	52.8	29.8	14.3	21.8	5.0	71.0

See footnote at end of table.

TABLE 12.—Average separable lean per 100 grams roasts and steaks and average composition of 100 grams separable lean and separable fat—Continued

Type of roast or steak	Weight of separable lean	Composition of separable lean			Composition of separable fat		
		Water	Protein	Fat	Water	Protein	Fat
	Grams	Grams	Grams	Grams	Grams	Grams	Grams
Swiss steaks:							
Clod:							
Raw frozen.....	80.7	70.5	21.0	7.3	16.6	7.6	77.5
Cooked.....	60.9	62.2	20.0	8.9	27.4	4.8	64.7
Chuck roll:							
Raw frozen.....	88.2	71.2	19.4	8.4	20.5	6.9	71.7
Cooked.....	85.8	61.3	25.2	10.4	42.4	5.8	47.7
Chuck tender:							
Raw frozen.....	63.8	74.5	19.6	4.5	26.7	10.0	62.0
Cooked.....	80.4	61.3	20.0	7.3	40.1	7.9	38.2
Outside of round:							
Raw frozen.....	80.7	72.8	20.1	5.3	18.0	6.4	75.4
Cooked.....	68.8	60.0	28.7	7.4	41.6	6.4	48.4
Rump butt:							
Raw frozen.....	71.6	70.6	19.6	7.8	18.4	5.2	76.2
Cooked.....	61.0	60.0	20.8	10.9	33.6	5.2	67.7

<sup>1</sup> Average of 2 cuts; other 2 not separated.

TABLE 13.—Percentages of separable lean in roasts and steaks and composition of separable lean and separable fat; raw and cooked

Type of roast or steak	Proportion of separable lean	Composition of separable lean			Composition of separable fat		
		Water	Protein	Fat	Water	Protein	Fat
	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Oven roasts:							
Raw.....	79.4	70.7	21.5	6.6	16.5	5.3	78.0
Cooked.....	70.5	54.1	20.8	12.6	15.3	5.7	72.7
Griddle-broiled steaks:							
Raw.....	78.0	70.7	21.5	6.6	16.5	5.3	78.0
Cooked.....	70.0	54.5	20.3	13.1	20.0	6.1	72.5
Flat roasts:							
Raw.....	83.0	71.4	20.4	7.6	19.3	6.2	74.3
Cooked.....	81.5	56.6	20.3	12.0	24.5	8.6	66.5
Swiss steaks:							
Raw.....	82.1	71.4	20.4	7.6	19.3	6.2	74.3
Cooked.....	73.4	61.0	20.8	9.9	30.5	5.7	54.2

The average serving allowance of 6.7 ounces of raw beef for roasts or steaks can be broken down into the food-energy contributions of the separable lean and separable fat (table 14). The food energy in the separable lean was practically unchanged by cooking. The separable fat contributed approximately one-half of the food energy in the raw beef and somewhat less than half in the cooked beef. Thus, the separable fat of these cuts, on the average, was approximately 20 percent of the weight of the raw beef but it contributed almost one-half of the food energy in the cooked beef.

TABLE 14.—*Calculated weight and food energy of separable lean and separable fat in 6.72 ounces<sup>1</sup> of raw roasts and steaks and corresponding cuts after cooking*

Type of roast or steak	Weight			Food energy	
	Total	Separable lean	Separable fat	Separable lean	Separable fat
Oven roasts:	<i>Grams</i>	<i>Grams</i>	<i>Grams</i>	<i>Calories</i>	<i>Calories</i>
Raw.....	190.5	151.2	35.8	220	281
Cooked.....	121.3	96.4	24.9	223	169
Griddle-broiled steaks:					
Raw.....	190.5	148.6	41.9	216	303
Cooked.....	128.2	89.7	38.5	214	331
Pot roasts:					
Raw.....	190.5	158.1	32.4	237	225
Cooked.....	125.2	102.0	23.2	234	147
Swiss steaks:					
Raw.....	190.5	156.4	34.1	235	236
Cooked.....	147.1	108.0	39.1	203	200

<sup>1</sup>The usual per-man allowance for these cuts.

## PART II

### Plate Waste from Oven Roasts, Trimmed and Untrimmed Procedures

For the study of the effect on plate waste of trimming external fat from beef, 2,076 pounds of the 7 cuts of boneless beef designated for oven roasts were used in serving 23 meals to 4,854 men in company-size messes at Fort Lee, Va. The beef was from regular procurement sources, and was prepared and served by Army mess personnel using regular equipment.

Specifications for the roasts limited external fat to  $\frac{3}{8}$  inch in thickness. The 7 cuts were cooked and served without removal of any of this fat; another 5 cuts were cooked and served with the fat trimmed to approximately  $\frac{1}{4}$  inch. The blade roll and knuckle of round were not trimmed, since the fat layer did not exceed  $\frac{1}{4}$  inch.

Physical data were obtained on the following: Weights of raw frozen beef issued to the mess, thaw juices, fat trimming, cooked meat, pan drippings, pan scrapings, meat not served, and beef in plate waste; also, the number of men served. All these data were calculated to a 100-man basis.

In this study no representative samples of the raw meat or the cooked meat could be obtained. It was possible, however, to get samples of the fat trim, thaw juices, pan drippings, beef not served, and beef in plate waste. These were sent to the laboratories of the Human Nutrition Research Branch, Agricultural Research Service, United States Department of Agriculture, Beltsville, Md., where they were analyzed for moisture, nitrogen, and ether-extractable fat.

## Results

### Raw Beef, Cooked and Served Items, and Plate Waste

The data in table 15 show the amounts of beef issued per 100 men and the percentages of this beef in the raw and cooked items. In making an overall comparison of the untrimmed-beef data with the

trimmed-beef data, the amount of beef in the individual cuts for roasts or steaks (dry heat) as given in table 5 were used as weighting factors. The summarized data (table 15) thus apply to roasts or steaks as a whole. Since the blade roll and the knuckle of round did not lend themselves to additional trimming, the data for these cuts were included in the summary data for both the untrimmed and the trimmed cuts.

The fat trim amounted to 6 percent of the average weight of the cuts. As a result of trimming, less fat was found in the beef not served and in plate waste than in these items from untrimmed cuts. Approximately two-thirds more beef not served appeared from the untrimmed cuts than from those trimmed (7.2 percent of the untrimmed beef as compared with 4.3 percent of the trimmed beef). The plate waste was approximately 38 percent more from the untrimmed cuts than from those trimmed (6.0 percent of the untrimmed beef as compared with 4.4 percent of the trimmed beef). Other items appeared unaffected by trimming. In each instance the cooked yield from the raw drained weight before cooking averaged about 65 percent; the amounts of pan drippings and scrapings were similar for untrimmed and trimmed cuts.

TABLE 15.—Percentage distribution of raw and cooked items from untrimmed and trimmed oven roasts, based on weight of frozen beef issued per 100 men

Type of oven roast	Weight of raw frozen beef	Before roasting			After roasting				
		Fat trim	Thaw juice	Drained thawed beef	Cooked drained beef	Drippings	Scrapings	Not served	Plate waste
		Kilo-grams	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Blade roll:									
Untrimmed.....	19.002	0	6.7	94.0	68.2	7.0	1.1	10.9	4.5
Inside of round:									
Untrimmed.....	10.260	0	5.8	94.9	56.4	10.1	.8	7.0	4.6
Trimmed.....	18.584	5.1	6.0	89.7	54.2	10.6	.6	3.7	3.8
Knuckle of round:									
Untrimmed.....	10.697	0	7.9	93.2	55.8	17.3	.7	5.0	2.4
Loin strip:									
Untrimmed.....	20.802	0	17.4	102.6	66.5	13.9	1.2	14.6	9.6
Trimmed.....	20.862	10.6	17.4	83.3	57.8	12.9	2.9	2.6	6.0
Sirloin butt:									
Untrimmed.....	19.890	0	16.3	105.4	63.7	14.0	.7	5.4	4.8
Trimmed.....	19.648	6.8	17.0	87.3	58.0	12.0	.3	2.6	4.7
Spencer roll:									
Untrimmed.....	19.112	0	2.7	95.0	63.3	11.1	.8	3.9	9.9
Trimmed <sup>1</sup> .....	18.658	6.1	5.5	89.4	63.3	12.3	.3	9.4	7.5
Tenderloin:									
Untrimmed.....	18.679	0	4.7	95.8	66.0	14.0	.7	2.9	7.4
Trimmed.....	17.076	11.2	4.5	84.0	54.6	9.1	1.0	0.4	3.2
Average for above cuts:									
Untrimmed.....	19.57		6.0	94.6	61.6	12.6	.8	7.2	6.0
Trimmed <sup>1</sup> .....	19.22	6.0	6.6	88.3	57.6	12.1	.6	4.3	4.4

<sup>1</sup> Single item.

<sup>2</sup> Including blade roll and knuckle of round.

### Composition of Recoverable Items, Including Plate Waste

Data on moisture, protein, and fat content obtained from the laboratory analyses of plate waste and other recoverable items from the untrimmed and trimmed roasts are shown (table 16). Results summarized (table 17) show that in amounts per 100 men, trimming of fat to  $\frac{1}{4}$  inch did not greatly affect the protein content in drippings, in beef not served, and in plate waste. In the pan drippings, the amount of fat was almost the same for untrimmed and trimmed cuts; but in beef not served and in plate waste, it was less than half as much for trimmed cuts as for untrimmed. Altogether, the fat in drippings, in beef not served, and in plate waste was one-third less for the trimmed than for the untrimmed cuts.

### Protein and Fat Consumed

The effects on amounts of protein and fat consumed, resulting from trimming fat from cuts designated for oven roasts, were calculated. The data (table 18) were obtained from those given in parts I and II on composition of the raw cuts, plate waste, and related items. The figures in table 18 assume that the cuts in both studies were the same in composition and were handled and cooked under similar conditions, although it is recognized that this was not necessarily true. Protein and fat in beef presumed eaten were obtained by subtracting the sum of percentages recovered in thaw juices, fat trim (if any), drippings, beef not served, and plate waste from 100.

TABLE 16.—Composition per 100 grams of items resulting from the preparation, cooking, and serving of oven roasts, untrimmed and trimmed

Type of oven roast	Fat trim			Thaw juice		Pan drippings			Beef not served			Plate waste		
	Water	Protein	Fat	Water	Protein	Water	Protein	Fat	Water	Protein	Fat	Water	Protein	Fat
	Grams	Grams	Grams	Grams	Grams	Grams	Grams	Grams	Grams	Grams	Grams	Grams	Grams	Grams
Blade roll:														
Untrimmed.....				88.2	10.2	50.3	5.0	40.8	52.2	23.6	23.3	30.2	14.2	53.0
Inside of round:														
Untrimmed.....				87.4	10.6	28.3	4.2	64.8	26.2	26.2	42.0	32.1	18.4	50.6
Trimmed.....	12.2	4.5	82.6	88.2	9.8	49.3	5.3	35.6	26.0	20.6	51.6	30.8	20.0	46.9
Knuckle of round:														
Untrimmed.....				89.4	8.8	70.2	5.7	11.0	48.1	32.6	17.2	40.4	23.4	46.6
Loin strip:														
Untrimmed.....				86.1	12.1	45.4	3.9	48.2	35.3	23.8	35.6	26.4	14.3	57.6
Trimmed.....	9.5	3.0	86.6	86.4	11.4	54.8	4.2	38.8	34.4	20.6	42.9	31.8	20.4	45.4
Sirloin butt:														
Untrimmed.....				87.8	9.9	50.4	5.1	41.2	48.4	19.4	30.4	26.2	14.2	57.3
Trimmed.....	10.8	3.2	84.0	85.5	11.3	55.2	5.5	33.8	39.2	20.4	37.5	26.4	16.2	56.0
Spencer roll:														
Untrimmed.....				87.0	11.3	40.0	4.4	52.4	27.8	15.4	55.4	24.4	12.2	62.6
Trimmed <sup>1</sup> .....	8.3	2.1	87.6	87.4	11.0	48.9	4.1	44.1	23.9	11.5	63.3	30.2	12.2	55.1
Tenderloin:														
Untrimmed.....				89.0	9.1	50.6	3.8	42.8	28.6	12.8	54.9	27.1	11.8	59.2
Trimmed.....	10.8	4.0	85.6	89.0	9.0	50.4	5.1	39.9	32.7	20.6	43.4	35.4	22.4	39.6

<sup>1</sup> Based on single item.



TABLE 17.—Amount of protein and fat in fat trim, drippings, beef not served, and plate waste from oven roasts, untrimmed and trimmed, in quantities per 100 men served

Item	Untrimmed roasts		Trimmed roasts	
	Protein	Fat	Protein	Fat
	Kilo-gram	Kilo-grams	Kilo-gram	Kilo-gram
Fat trim.....			0.046	0.088
Drippings.....	0.094	1.055	.121	.066
Beef not served.....	.180	.774	.170	.358
Plate waste.....	.138	.605	.100	.335

TABLE 18.—Distribution of protein and fat in recoverable items in cooking and serving oven roasts, in terms of percentages of the amounts of protein and fat in raw beef

Item	Untrimmed roasts		Trimmed roasts	
	Protein	Fat	Protein	Fat
	Percent	Percent	Percent	Percent
Thaw juices.....	3.0		3.2	
Fat trim.....			1.2	24.4
Pan drippings.....	3.4	25.1	3.8	18.8
Beef not served.....	9.8	12.1	4.7	6.4
Beef in plate waste.....	5.2	16.2	4.6	10.4
Beef presumed eaten.....	78.5	46.0	82.0	40.1

The data show that of the protein in the raw issued weight, approximately 80 percent was found in the beef presumed eaten. Any difference between 78 percent of protein in the untrimmed cuts and 82 percent in the trimmed cuts was probably nonsignificant. The percentage of fat in the raw issued weight appearing in beef presumed eaten was 46 percent for the untrimmed cuts and 40 percent in the trimmed cuts. Because of the large quantity of fat reserved in fat trim from the trimmed cuts, the fat drippings from the trimmed cuts would probably be used entirely in making gravy. On the other hand, part of the fat in drippings from the untrimmed cuts would not be used in making gravy. The results would indicate therefore that trimming would not reduce the fat consumed if the gravies were included.

These findings indicate that further trimming of surface fat in the processing of beef at the packing plants would result in a saving in weight to be handled and stored in valuable freezing space, without any appreciable effect on the nutritive value of the beef eaten.

## PART III

Composition of Boneless Beef as Cooked and Served,  
and the Amounts of Protein, Fat, and Food Energy in  
Beef or Beef Recipe Consumed

## Procedures

The study of boneless beef as regularly issued, cooked, and served in Army messes was made at 5 widely separated locations in the United States: Camp Roberts, Calif.; Fort Leonard Wood, Mo.; Fort Knox, Ky.; Camp Rucker, Ala.; and Fort Jackson, S. C. Of a total of 560,000 pounds of beef made available from 6 processors, 52,682 pounds were issued to furnish 542 meals to 109,128 men.

The plan called for 28 different combinations of cut or form of beef and cooking method. The 7 cuts designated for roasts and steaks (dry heat) and the 5 designated for roasts and steaks (moist heat) were prepared both as roasts and as steaks; the diced beef was prepared as stew; and the ground beef was prepared as meat loaf, hamburgers, and "beefburgers."

All kinds of Army activities were represented through a statistically random selection of the companies available in each of these locations; in this way, the companies were distributed among the different cooking methods and cuts or forms of beef. Each mess was given only 1 kind of cut to be used in a mess meal. With 56 messes participating in 112 meals at each location, any given mess was used twice, but each time for a different cut or form of beef and cooking method. With a few exceptions, each cut or form and cooking method was replicated 4 times—twice at noon and twice in the evening. A total of 542 meals was served out of the 560 called for by the plan. The usual Army personnel cooked and served the meals. The data were recorded and the samples procured with the least possible interference with normal operations.

Cooking methods were those designated in the manual on recipes (5) for oven roasts, griddle-broiled steaks, pot roasts, Swiss steaks, and stew, and also for 3 ground meat recipes—meat loaf, "beefburger," and hamburger. Meat loaf and "beefburger" contained added ingredients, but the hamburger consisted of ground beef with seasoning only. In table 19, the amounts of 38 recipe ingredients are shown in average amounts per 100 men. The cooks were at liberty to prepare the beef as they normally would, and deviations from the recipe manual were not uncommon. There was a tendency to cook pot roasts as oven roasts.

For raw samples to represent the cuts designated for oven roasts and griddle-broiled steaks and those designated for pot roasts and Swiss steaks, every 10th steak was taken. Approximately 10 percent of the diced meat and 10 percent of the ground meat were also used for the raw samples. Cooked samples as served were obtained by taking every 10th serving. All of the beef in plate waste was taken as the plate-waste sample. At each location samples from the messes were pooled according to cut and cooking method. For instance, 4 samples

TABLE 19.—Average weights of ingredients used in average boneless beef recipes in amounts per 100 men

Ingredient	Pot roasts						Swiss steaks						Diced meat—stew	Ground meat	
	Average	Clod	Chuck roll	Outside of round	Rump butt	Chuck tender	Average	Clod	Chuck roll	Outside of round	Rump butt	Chuck tender		Meat loaf	"Beef-burger"
Beef, boneless..... pounds	43.8	44.8	41.6	41.1	46.0	45.4	45.0	43.8	44.3	45.7	43.4	47.6	27.1	30.4	38.4
Beans, string..... do													.4		
Bread, crumbs..... do														1.8	.4
Carrots..... do	1.1			5.3									4.6	1.1	.0
Celery..... do	.04			.2			.02	.06		.05			1.8	3.3	2.2
Eggs..... do														.4	
Fat..... do							.3	.4	.2	.2	.4	.3		.3	.03
Flour..... do							1.4	1.6	.9	1.0	1.2	2.6	1.2		
Gravy..... do							.7		3.7						
Gravy and onions..... do							.2		1.0						
Onions:															
Raw..... do	.02			.1			3.1	3.0	3.0	3.0	3.8	2.9	3.6	2.2	2.6
Dehydrated..... do	.1			.3			.05			.24			.14		
Potatoes..... do													8.4		
Tomatoes, canned..... do							3.1	3.2	3.2	3.2	2.4	3.7	2.0		
Tomato:															
Catsup..... do							2.0	3.1	1.5	2.2	1.6	1.8	5.1	.2	
Paste..... do							1.1	1.3	.9	1.2	1.3	.8	1.6		
Puree..... do							.7	1.2	.2	2.6	.6	.4			
Water..... do							9.8	11.3	6.8	9.7	10.6	10.8	14.8	.6	1.0
Peas..... ounces													3.7		
Peppers, green..... do							.5	.9		.6		.9	1.1	4.1	7.2
Miscellaneous:															
Bread..... do														3.0	5.8
Celery and catsup..... do													2.4		
Cornstarch..... do							.1	.6							
Crackers..... do														9.8	7.2
Crackers, soaked..... do														.15	3.0
Garlic..... do														.45	
Gravy base..... do											.6				
Milk..... do							.1								
Pimento..... do													3.8		
Sauces:															
Chili..... do							.2		.8						
Steak..... do							.4		1.6			.5		5	
Worcestershire..... do							.2	.2	.7						
Sugar..... do							.3								
Tenderizer..... do							.08			1.4					
Tomato juice..... do							1.8				8.8		4		
Tomato juice and paste..... do							1.8		9.2				3.7		

of roast tenderloin from 4 mess meals at 1 location were ground 3 times and a representative subsample taken for the laboratory analyses. Samples were stored frozen and shipped frozen.

At each installation, the data included a count of the total number of men served, of men taking beef, and of men receiving second servings. Weights were obtained of the beef as received, the thawed drained beef, the recipe ingredients used, the drained cooked beef, the beef not served, and the beef or beef recipe in plate waste.

Laboratory analyses of the representative subsamples which had been ground at each location were carried out by first drying under infrared lamps as was done previously (3) and extracting the entire subsample in a Soxhlet apparatus for fat (1, p. 359). The nonfat portion was then ground through 20 mesh in a Wiley mill, and analyzed for residual moisture by drying in a vacuum oven at 70° C. and less than 25 mm. of mercury; it was also analyzed for ash (4) and for nitrogen (1, p. 12).

## Results

### Physical Data

The amounts of raw beef issued per 100 men, the amounts of cooked beef served and not served, and the amounts of plate waste were averaged, usually for 20 messes for each cut. These are given in table 20. The weights shown for raw beef and served cooked beef represent

TABLE 20.—Averaged amounts of beef per 100 men in raw issue of boneless beef, in drained cooked beef or beef recipe served and not served, and in plate waste

Type of beef or beef recipe	Issued raw <sup>1</sup>	Served cooked <sup>2</sup>	Not served, cooked	Plate waste
	Pounds	Pounds	Pounds	Pounds
Oven roasts <sup>2</sup>	43.5	25.7	1.5	2.5
Tenderloin	43.4	25.8	1.2	2.9
Loin strip	42.5	24.6	1.5	2.8
Spencer roll	46.0	28.5	1.9	3.2
Blade roll	42.4	23.9	1.7	1.3
Inside of round	42.1	25.3	.9	2.0
Knuckle of round	46.1	25.0	2.8	2.3
Sirloin butt	42.8	25.8	1.1	2.6
Griddle-broiled steaks <sup>2</sup>	45.0	20.5	2.8	4.8
Tenderloin	45.8	26.1	3.2	4.0
Loin strip	44.2	26.0	3.2	5.2
Spencer roll	43.0	28.2	1.7	6.4
Blade roll	40.9	24.0	2.6	3.2
Inside of round	42.9	20.4	.0	4.4
Knuckle of round	49.8	20.0	4.3	3.0
Sirloin butt	40.0	25.3	4.4	5.2
Pot roasts <sup>2</sup>	44.5	24.4	4.0	2.8
Clod	45.7	25.5	4.8	3.2
Chuck roll	42.8	22.0	3.3	2.6
Outside of round	41.8	23.8	3.3	2.0
Rump butt	47.4	20.3	4.3	3.5
Chuck tender	47.8	22.0	4.2	2.3
Swiss steaks <sup>2</sup>	45.0	48.5	5.1	4.3
Clod	45.1	48.2	4.5	5.7
Chuck roll	45.8	45.7	0.1	3.1
Outside of round	40.0	52.7	6.1	4.0
Rump butt	44.2	48.7	1.5	4.4
Chuck tender	48.2	47.4	8.4	2.5
Stew	28.8	52.4	0.2	5.1
Meat loaf	31.4	20.1	1.0	.8
"Beefburger"	39.0	27.1	4.5	.9
Hamburger	41.8	23.1	2.5	1.1

<sup>1</sup> Corrected for amounts taken for analytical samples.

<sup>2</sup> Figures are averages weighted according to the percentage of cuts and forms of 4-way boneless beef (table 6).

the amounts used for the men; amounts taken for analysis have been deducted. The averages given for roasts and steaks are weighted according to the occurrence of the individual cuts in beef designed for roasts or steaks, cooked by dry heat or moist heat (table 5). For example, the average issue for oven roasts, 43.5 pounds per 100 men, is a weighted value for the 7 cuts as used in 125 messes. Actually, there was a considerable range in the quantity of meat issued per 100 men, as shown in table 21. The issued weight of beef for oven roasts, for instance, ranged from 28.3 to 81.4 pounds per 100 men, whereas the standard of issue was 42 pounds.

The amount of plate waste was found to correlate linearly with the issued weight, except for ground meat (table 21 and fig. 2). From the

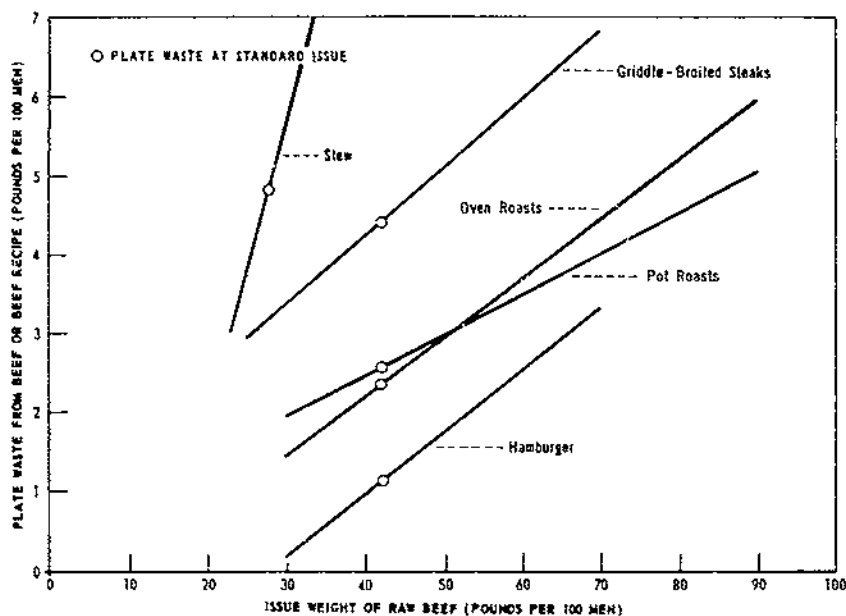


FIGURE 2.—Plate waste from cooked beef or beef recipe as served, expressed as a function of the issue weight of raw boned beef per 100 men.

average slope of the lines for griddle-broiled steaks, oven roasts, and hamburger (fig. 2), it can be seen that the plate waste was a certain percentage of the raw weight regardless of the amount of beef issued per 100 men. This may be interpreted to mean that the men ate beef even when the issue was excessive, and discarded as plate waste only that portion that would be plate waste on a much smaller issue.

Table 21 and figure 2 also show the expected plate waste for a standard issue. For example, an issue of 42 pounds of beef for oven roasts would have an expected plate waste of 2.35 pounds, whereas the same issue cooked as griddle-broiled steaks would have an expected plate waste of 4.42 pounds.

TABLE 21.—Correlations between raw weights of beef as issued per 100 men and corresponding amounts of plate waste

Type of beef	Number of mess meals	Range of issue per 100 men		Correlation coefficient <sup>1</sup>	t:	Linear coefficients		Standard issue per 100 men	Plate waste calculated from standard issue <sup>2</sup>
		Low	High			a	b		
Roasts and steaks (dry heat):		<i>Pounds</i>	<i>Pounds</i>					<i>Pounds</i>	<i>Pounds</i>
Oven roasts.....	125	23.3	81.4	0.3690**	4.405**	-0.8037	0.0752	42	2.551±1.29
Griddle-broiled steaks.....	136	21.2	96.6	.3446**	4.244**	.8300	.0854	42	4.417±2.33
Roasts and steaks (moist heat):									
Pot roasts.....	92	30.4	112.2	.4219**	4.410**	.4150	.0516	42	2.582±1.27
Swiss steaks.....	94	31.4	76.7	.1696	1.561			42	
Diced beef:									
Stew.....	20	21.9	64.6	.8691**	7.154**	-5.460	.3670	28	4.816±2.06
Ground beef:									
Meat loaf.....	20	22.4	33.9	.1676	.7030			31	
"Beefburger".....	20	24.8	90.3	.1191	.5091			31	
Hamburger.....	20	29.0	63.6	.4830*	2.3452*	-2.178	.0788	42	1.132±1.08

<sup>1</sup> 1 asterisk indicates significant; 2 asterisks indicate highly significant.

<sup>2</sup> Standard error also shown.

### Composition Data

The composition and energy value of the raw beef, of the cooked beef or beef recipe as served, and of the corresponding plate waste have been summarized (table 22). The data show that for roasts, steaks, and stew the percentage of fat in the plate waste was considerably higher than in the beef or beef recipe served, whereas for the ground meat recipes—meat loaf, hamburger, and "beefburger"—the percentages of fat in plate waste and in served portions were similar. This was to be expected because the fat could be cut from the servings of former items but not from the latter.

The percentages of fat in plate waste were correlated in all instances, with the percentages of fat in the served portion. Correlation coefficients, linear coefficients, and related data are given (table 23); data for stew are not included. As shown graphically in figure 3, results from the roasts and steaks were so nearly alike that all data could be pooled to obtain a common line. Statistically, the data were found to have correlation coefficients that were highly significant. The average served roasts or steaks contained 21.4 percent fat and the corresponding plate waste was 37.5 percent fat. The entire plate-waste data suggest that fat was trimmed from meat servings.

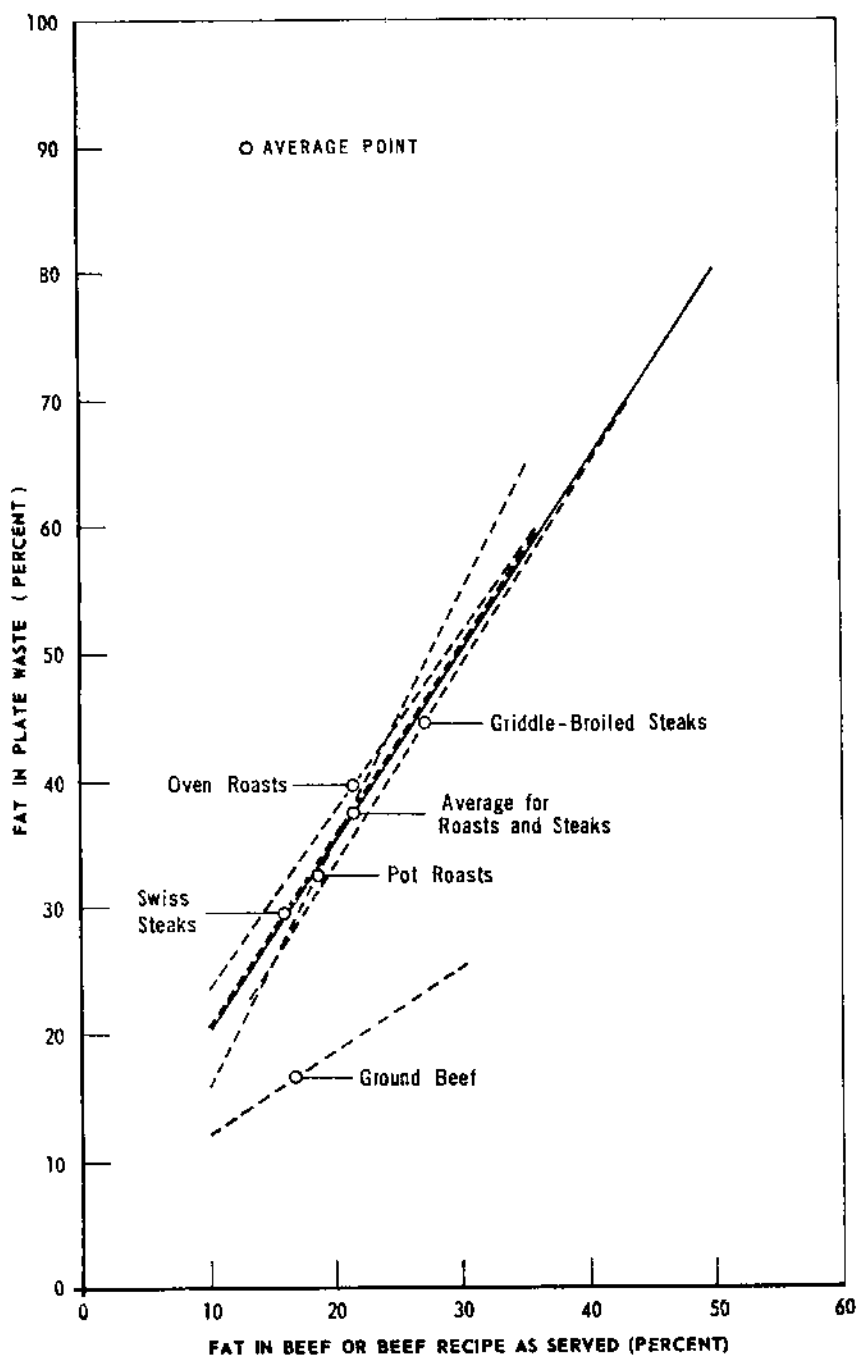


FIGURE 3.—Percentages of fat in plate waste expressed as a function of the percentages of fat in the cooked beef or beef recipe as served.



TABLE 22.—Summary of averaged data on composition and food energy per 100 grams of raw boneless beef, of beef cooked and served, and of plate waste

Type of beef or beef recipe	Raw						Served, cooked						Plate waste					
	Water	Energy value	Protein	Fat	Total carbohydrate	Ash	Water	Energy value	Protein	Fat	Total carbohydrate	Ash	Water	Energy value	Protein	Fat	Total carbohydrate	Ash
	Grams	Calories	Grams	Grams	Gram	Gram	Grams	Calories	Grams	Grams	Grams	Grams	Grams	Calories	Grams	Grams	Grams	Grams
Oven roasts <sup>1</sup> .....							49.8	304	28.6	19.9	0.75	1.10	40.1	435	19.0	38.7	1.25	1.02
Blade roll.....							46.4	337	28.1	23.8	.71	1.05	38.1	446	20.2	39.3	1.28	1.14
Inside of round.....							54.2	254	30.8	13.3	.77	1.18	43.7	390	20.0	33.8	1.41	1.03
Knuckle of round.....							53.0	256	31.0	13.3	.92	1.20	50.9	312	24.1	22.6	1.27	1.13
Loin strip.....							46.9	332	28.0	23.1	.60	1.10	34.9	484	18.4	44.4	1.23	1.09
Sirloin butt.....							49.1	314	27.9	21.4	.60	1.00	37.5	468	17.2	43.2	1.22	.88
Spencer roll.....							44.8	366	25.4	28.4	.43	.99	35.7	487	16.7	45.0	1.03	.95
Tenderloin.....							46.5	346	25.7	25.7	.94	1.12	34.4	502	15.8	47.6	1.13	.99
Griddle-broiled steaks <sup>1</sup> .....	61.5	252	17.8	19.5	0.44	0.78	45.7	350	25.5	20.0	1.68	1.21	37.5	468	16.5	43.2	1.04	.94
Blade roll.....	62.3	246	17.7	19.0	.37	.75	44.0	362	25.7	27.5	.95	1.23	38.3	454	18.2	41.0	1.54	.96
Inside of round.....	65.0	204	19.2	13.5	.51	.87	49.4	304	27.5	19.8	1.99	1.31	41.0	411	19.0	35.2	2.03	.99
Knuckle of round.....	60.9	166	19.3	9.2	.61	.89	53.3	264	28.9	14.7	1.80	1.30	52.1	302	22.8	21.6	2.36	1.18
Loin strip.....	57.3	203	17.5	24.2	.25	.71	41.9	390	24.0	30.9	2.06	1.14	30.7	545	13.5	53.1	1.89	.77
Sirloin butt.....	60.3	203	17.5	20.0	.55	.79	44.8	303	24.5	27.9	1.68	1.29	36.1	488	14.6	46.3	2.09	.91
Spencer roll.....	53.2	340	15.6	30.3	.20	.66	38.2	437	22.4	37.4	.99	1.01	28.8	573	11.5	57.3	1.53	.77
Tenderloin.....	57.1	303	15.7	26.1	.45	.70	42.6	390	23.2	31.6	1.35	1.22	28.9	566	12.0	50.4	1.67	1.03
Pot roasts <sup>1</sup> .....							51.1	296	28.0	19.3	.70	1.03	44.9	389	19.0	33.3	1.28	.96
Clod.....							51.2	298	27.4	19.9	.54	1.17	44.3	399	18.7	34.0	1.18	.98
Chuck roll.....							50.4	301	28.4	19.7	.70	.95	48.2	348	21.7	27.8	1.33	.95
Chuck tender.....							54.7	245	31.4	11.8	1.14	1.04	53.8	271	27.0	16.6	1.08	1.42
Outside of round.....							53.9	266	29.1	18.5	.52	1.00	45.5	384	19.5	32.7	1.40	.98
Rump butt.....							46.8	346	25.7	25.0	.90	1.02	35.2	503	14.4	48.4	1.33	.73
Swiss steaks <sup>1</sup> .....	64.2	227	18.0	16.6	.43	.81	59.0	244	19.8	16.0	3.82	1.31	49.5	350	16.5	29.6	3.37	1.08
Clod.....	64.0	230	18.0	17.0	.32	.80	61.1	233	17.1	15.8	4.74	1.32	49.7	354	14.3	30.6	4.24	1.06
Chuck roll.....	65.4	214	18.3	15.0	.53	.79	60.1	233	19.9	14.8	3.73	1.47	53.5	302	18.7	23.2	3.32	1.28
Chuck tender.....	71.3	158	19.2	8.4	.41	.86	60.6	212	24.0	10.7	3.45	1.20	53.3	296	21.0	21.6	2.91	1.14
Outside of round.....	65.4	212	18.5	14.7	.49	.85	58.6	239	22.4	14.4	3.43	1.15	48.7	355	17.9	29.7	2.93	.89
Rump butt.....	57.4	295	16.5	24.0	.41	.77	52.0	311	20.4	23.8	2.60	1.24	40.8	450	13.3	42.6	2.31	.97
Stew.....	59.9	279	16.5	22.4	.40	.74	53.3	152	9.1	9.7	7.60	1.30	62.7	250	9.5	20.4	6.62	.84
"Beefburger".....	55.7	315	16.0	27.3	.27	.67	57.8	245	21.0	15.4	4.40	1.48	58.8	211	20.0	15.1	5.04	1.06
Hamburger.....	56.1	311	16.1	26.9	.31	.69	53.0	280	25.3	18.4	1.30	1.39	55.2	269	23.9	17.6	2.13	1.15
Meat loaf.....	55.3	319	16.0	27.8	.45	.68	59.2	239	17.6	15.3	6.63	1.29	56.3	269	17.9	17.0	7.56	1.18

<sup>1</sup> Figures are averages weighted according to percentage of cut in type of 4-way boneless beef.

TABLE 23.—Correlation between fat in beef or beef recipe served and fat in plate waste

Type of beef or beef recipe	Number of cooked samples	Average fat in served beef <sup>1</sup>	Average fat in plate waste <sup>1</sup>	Correlation coefficient <sup>2</sup>	t <sup>2</sup>	Linear coefficients	
						a	b
		Percent	Percent				
Oven roasts	35	21.3	39.5	0.8174**	8.0970**	9.559	1.406
Griddle-broiled steaks	35	27.1	44.4	.9157**	13.088**	1.866	1.576
Pot roasts	24	18.8	32.7	.8531**	7.7377**	-4.200	1.961
Swiss steaks	25	15.9	29.5	.7651**	5.0887**	5.727	1.498
All roasts and steaks	119	21.38	37.48	.8766**	19.088**	5.434	1.499
All ground meat recipes	15	16.4	16.6	.6117**	2.7878*	3.940	.649

<sup>1</sup> Mean values from linear equation.<sup>2</sup> 1 asterisk indicates significant; 2 asterisks indicate highly significant.

The fat loss as plate waste may not, however, be as great as the fat loss during cooking. The data are summarized (table 24) to show the cooked yield of beef or beef recipe from the raw issue weight of beef, and the corresponding fat losses during cooking and in plate waste in terms of the percentage of fat in the raw issue of beef. Only for griddle-broiled steaks was fat loss greater in the plate waste than during cooking. Of course, the fat lost during cooking would be included, in part, as fat in drippings used for gravy and in this way made available to the men. Fat losses during cooking of meat loaf and "beefburger," where the recipes called for bread crumbs or cracker crumbs, were about as great as fat losses during cooking of hamburger, which consisted of meat and seasoning without crumbs or other ingredients. The fat loss in plate waste from ground meat recipes was very little—only 1 to 2 percent. Altogether, the fat loss during cooking and in plate waste averaged about 50 percent of the amount of fat in the original cuts of beef.

TABLE 24.—Summary of cooked yields of boneless beef and of fat loss during cooking and as plate waste

Type of beef or beef recipe	Cooked yield	Fat loss <sup>1</sup>	
		During cooking	As plate waste
	Percent	Percent	Percent
Oven roasts	62	36	12
Griddle-broiled steaks	64	13	24
Pot roasts	64	26	13
Meat loaf	91	48	2
Beefburger	80	55	1
Hamburger	61	58	2

<sup>1</sup> Based on fat in raw beef.

### Protein and Fat in Raw Beef From Eight Carcasses and From Field Study

A comparison of the protein and fat content of the raw beef from the 8 carcasses and from the 5 Army field installations is shown (table 25). Statistical analysis of variance of the data showed that only in the fat content of the ground meat was there a real difference between the average values. The 27.4 percent fat in the ground meat

from the field study was statistically greater than the 24.6 percent fat in the ground meat from the 8 carcasses. This might be expected since the amount of fat in the ground meat of the 8 carcasses was intended to average approximately 25 percent, whereas the specifications for the ground meat at the time of the 1953 field study permitted as much as 30 percent fat. Except for the ground meat, the average composition of the raw boneless beef from the 2 studies would be considered equivalent.

TABLE 25.—Range and average percentages of protein and fat in boneless beef from 8 carcasses and from 5 Army field installations

Type and source of beef	Protein		Fat	
	Range	Average	Range	Average
Roasts or steaks (dry heat):				
8 carcasses.....	16.9-18.5	17.8	20.1-26.0	22.1
5 field installations.....	17.1-18.4	17.8	17.5-21.7	19.7
Roasts or steaks (moist heat):				
8 carcasses.....	17.0-18.6	17.8	16.8-21.3	18.8
5 field installations.....	17.3-18.6	18.0	13.9-20.1	16.6
Diced beef:				
8 carcasses.....	14.8-24.0	17.1	17.7-26.2	22.0
5 field installations.....	15.8-17.0	16.5	18.8-26.9	22.4
Ground beef:				
8 carcasses.....	15.3-17.7	16.1	22.2-26.9	24.6
5 field installations.....	15.0-16.9	16.0	23.2-30.7	27.3

<sup>1</sup> Statistically highly significant difference between 24.6 and 27.3.

The data from 8 carcasses are of value in showing the distribution of protein and fat in boneless beef on a carcass basis, and also the amounts of protein and fat in such items as thaw juices and pan drippings by cut, by cooking method, and on a carcass basis. The data from 5 installations are of value in being representative of large quantities of beef, and provide usable data on quantities of protein, fat, and calories in beef as served, in beef in plate waste, and in beef consumed.

#### Protein and Fat Content and Energy Value of Beef Consumed

The data in table 26 show the average amounts of protein, fat, and food energy per 100 men in boneless beef as issued, in the cooked beef or beef recipe, in the portion not served, in the beef presumably eaten, and in the plate waste. The amounts consumed were obtained by subtraction. In the amounts of beef in different forms eaten per 100 men, there was a range in protein of from 1,946 grams for stew to 4,043 grams for Swiss steak; in fat, from 1,700 grams for pot roast to 2,964 for Swiss steak; and in food energy, from 27,794 calories for hamburger to 46,813 calories for Swiss steak.

For purposes of comparison between cooking methods for boneless beef, the data in table 26 on amounts of protein, fat, and food energy in the beef consumed and related items were calculated in terms of the percentages of the amounts issued as raw beef. Percentages over 100 in the cooked recipe show that the added ingredients contributed fair amounts. Although more fat was retained by griddle broiling than by oven roasting (79 as compared with 60 percent),

there was twice as much fat in the plate waste from the steaks as from the roasts and consequently less difference in the amounts of fat consumed—49 and 55 percent, respectively.

TABLE 26.—Average amounts of protein, fat, and food-energy content of cooked beef served and not served, in plate waste, and in beef presumed eaten, compared with that of the raw boneless beef as issued per 100 men

Type of beef or beef recipe and related items	Protein		Fat		Food energy	
	Grams	Percent	Grams	Percent	Calories	Percent
<b>Oven roasts:</b>						
Issued	3,524		3,828		49,677	
Served	3,341	94.8	2,313	60.4	35,466	71.4
Not served	195	5.5	155	4.0	2,070	4.2
Plate waste	215	6.1	449	11.5	4,058	8.2
Presumed eaten	3,126	88.7	1,873	48.9	30,528	61.5
<b>Griddle-broiled steaks:</b>						
Issued	3,845		3,960		51,390	
Served	3,074	84.3	3,127	79.0	42,135	82.0
Not served	325	8.9	330	8.3	4,452	8.7
Plate waste	355	9.7	941	23.8	10,186	19.6
Presumed eaten	2,719	74.6	2,186	55.2	31,949	62.2
<b>Pot roasts:</b>						
Issued	3,640		3,338		45,702	
Served	3,069	84.0	2,123	63.6	32,745	71.6
Not served	568	15.0	348	10.4	5,308	11.7
Plate waste	246	6.7	423	12.7	4,945	10.5
Presumed eaten	2,853	78.2	1,700	50.9	27,800	60.8
<b>Swiss steaks:</b>						
Issued	3,730		3,420		46,831	
Served	4,365	116.7	3,540	104.5	53,641	114.5
Not served	459	12.3	372	10.9	5,641	12.0
Plate waste	322	8.6	576	16.8	6,828	14.6
Presumed eaten	4,043	108.1	2,964	86.7	47,813	99.9
<b>Stew:</b>						
Issued	2,160		2,938		35,654	
Served	2,148	99.4	2,306	78.5	36,208	101.6
Not served	264	11.8	273	9.3	4,284	12.0
Plate waste	219	10.1	469	16.0	5,778	16.2
Presumed eaten	1,929	59.3	1,837	62.5	30,430	85.4
<b>Meat loaf:</b>						
Issued	2,201		3,956		45,373	
Served	2,325	105.0	2,068	50.8	31,063	69.0
Not served	86	3.5	69	1.7	1,065	2.4
Plate waste	65	2.9	92	2.3	945	2.1
Presumed eaten	2,263	102.1	1,946	49.2	30,658	67.5
<b>Beefburger:</b>						
Issued	2,891		4,010		56,549	
Served	2,574	89.0	1,897	48.6	36,135	63.3
Not served	428	14.8	315	8.4	5,004	8.8
Plate waste	82	2.8	61	1.5	985	1.7
Presumed eaten	2,492	86.2	1,836	47.4	29,150	51.6
<b>Hamburger:</b>						
Issued	3,051		5,100		59,690	
Served	2,656	87.0	1,949	38.0	29,314	49.1
Not served	288	9.4	210	4.1	3,172	5.3
Plate waste	120	3.9	88	1.7	1,520	2.6
Presumed eaten	2,536	83.1	1,852	36.3	27,794	46.5

For the ground-meat recipes, half or less of the fat in the raw beef was found in the cooked-beef recipe. Although less than 2 percent of the fat appeared in the plate waste, the men consumed as ground-meat recipes less than half of the original fat. As shown by a comparison of "beefburgers" and hamburgers, the presence of bread crumbs and crackers in "beefburgers" did not affect the fat retention in the cooked recipe or in the amounts consumed. The 36 to 37 percent of fat consumed in the ground meat for hamburgers and "beefburgers" was exclusive of amounts in the gravies and cooking juices.

Table 27 shows the percentages of protein, fat, and food energy attributable to the beef in the raw recipe. The data were obtained

by calculating the amounts contributed by the average recipe ingredients (table 19) according to the published food-composition tables (8) and subtracting these amounts from the values obtained by analysis of the beef recipes. Since most of the protein, fat, and food energy was contributed by the beef, it was assumed that in the cooked recipe the beef-contributed protein, fat, and food energy were in the same proportion as in the raw, and with no appreciable error.

TABLE 27.—Percentages of protein, fat, and food energy of the average raw recipe contributed by 4-way boneless beef

Recipe	Protein	Fat	Food energy
	Percent	Percent	Percent
Swiss steak .....	97	96	89
Stew .....	88	95	78
Meat loaf .....	96	94	86
"Beefburger" .....	93	99	92

Based on the carcass proportion of the roasts or steaks (dry heat), roasts or steaks (moist heat), diced beef, and ground beef, and an equal representation among the cooking methods used in this study for the types of beef, the percentages of protein, fat, and food energy in the beef consumed were calculated from those in the beef only, not including the recipe ingredients. These data showed that the beef or beef recipe eaten contained 84 percent of the beef protein, 51 percent of the beef fat, and 67 percent of the beef energy value. Also on this basis, 6 percent of the beef protein, 11 percent of the beef fat, and 10 percent of the food energy were found in the plate waste. Of these items, 7 percent of the food energy, 9 percent of the protein, and 6 percent of the fat in the issued beef were left as unserved edible beef at the serving table.

### Literature Cited

- (1) ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.  
1950. OFFICIAL METHODS OF ANALYSIS. . . Ed. 7, 910 pp., illus.  
Washington, D. C.
- (2) GRAF, R. L.<sup>3</sup>  
1949. BONELESS BEEF STUDY. [U. S. Quartermaster Corps], Quartermaster Food and Container Inst. for the Armed Forces, Interim Rpt. 1; Proj. "Meats, Frozen," 7-84-06-20, [24] pp. Chicago, Ill. [Processed.]
- (3) HEWSTON, E. M., DAWSON, E. H., ALEXANDER, L. M., and ORENT-KEILES, E.  
1948. VITAMIN AND MINERAL CONTENT OF CERTAIN FOODS AS AFFECTED BY HOME PREPARATION. U. S. Dept. Agr. Misc. Pub. 628, 76 pp., illus.
- (4) LINNIG, F. J., MILLIKEN, L. T., and COHEN, R. I.  
1951. DETERMINATION OF ASH IN GR-S SYNTHETIC RUBBERS AND LATICES. [U. S.] Natl. Bur. Standards, Jour. Res. 47: 135-138, illus.
- (5) UNITED STATES DEPARTMENTS OF THE ARMY AND THE AIR FORCE.  
1950. RECIPES. U. S. Dept. of the Army Tech. Manual TM 10-412, (also titled Dept. of the Air Force Manual AFM 146-3), 497 pp. Washington.

<sup>3</sup> Publication may not be easily obtained.

- (6) UNITED STATES VETERINARY CORPS AND QUARTERMASTER CORPS INSPECTION SERVICE.<sup>4</sup>  
1951. [INSPECTION OF] BEEF, BONELESS, FROZEN, (4-WAY) [UNDER] MILITARY SPECIFICATION MIL-B-10017A(QMC). U. S. Quartermaster Corps Insp. Serv., SIP (Tentative) SUBS T-21, 28 pp., illus. New York. [Processed.]
- (7) WATT, B. K., and MERRILL, A. L.  
1950. COMPOSITION OF FOODS—RAW, PROCESSED, PREPARED. U. S. Dept. Agr., Agr. Handb. 8, 147 pp. [Processed.]
- (8) WOLGAMOT, I. H.  
1952. BEEF—FACTS FOR CONSUMER EDUCATION. U. S. Dept. Agr., Agr. Inform. Bul. 84, 21 pp., illus.

---

<sup>4</sup> See footnote 3.

**END**