MEAT and CARCASS EVALUATION

A Review of Trends in Ground Beef Production

P. A. Will and R. L. Henrickson

Story in Brief

If the beef industry had to pick a single product to best meet today's market need, that product would be ground beef. The American Meat Institute estimated that in 1975 the American public consumed 50 billion hamburgers. In 1970, ground beef of all types represented one-fifth (20 percent) of all beef consumed in the United States. Today, ground beef consumption represents twice that amount (40 percent) of all beef consumed in the U.S. Estimates from various sources indicate that by 1982 the consumption of ground beef will be more than half (50 to 60 percent) of all beef supply. When one considers that the majority of the U.S. population is less than 25 years old, there is little doubt that a "Hamburger Society" has been created.

Introduction

Until recently, ground beef was mainly considered a method to utilize trimmings and less tender cuts. But while the industry considered ground beef as a poor cousin to steak and roast, the consumer considered ground beef as an excellent product to meet its needs.

The trend today is clearly toward everyday low prices for ground beef and high prices for the so-called "better" cuts of beef. The average retail price of all beef in the United States during 1976 was about 85¢ per pound, compared to an average of $1.86 for the "better" cuts.

Material

Hamburger, ground beef or chopped beef can be defined in a legal manner as chopped fresh and/or frozen beef with or without the addition of beef fat and/or seasoning. It shall not contain more than a total of 30 percent fat.

Acceptable seasonings include salt, sweetening agents, flavorings, spices, monosodium glutamate and hydrolyzed vegetable protein, provided they are added in condimental proportions. Paprika and other substances which might influence the coloration of the product are not included in the acceptable seasoning category. No water may be added, and no tongue, heart, weasand, or kidney is permitted (Encyclo. of label. Meat & Poultry Prod.).

Results and Discussion

Nutritionally, ground beef is on a par with any other beef cut. Meat processors are constantly attempting to look at new alternatives to produce a cooked product with excellent aroma, flavor, tenderness and juiciness. One recent technical advance has been flake cutting of meat. Conventional plate grinders squeeze and extrude meat through perforated plates. On the other hand, flake cutting has a stationary cutting head made up of a continuous ring of cutting surfaces. Meat is forced across the cutting edges by high speed impeller, producing thin uniformly cut flakes of meat without being crushed. The advantages claimed for flake cutting include improved texture, retention of natural juices (less drip loss), better binding and cohesive properties, reduced cooking loss, improved sensory characteristics and elimination of gristle and connective tissue (Fenen, 1972). Research conducted by Randall and Lammond (1977) using boneless beef rounds and beef kidney fat compared flake-cutting and grinding for acceptability and quality for hamburger patties with 15 percent fat. Preweighed frozen patties were allowed to drip freely on filter paper pads at room temperature for 3 hours reaching a surface temperature of 18.5 C. After determining "thaw-drip" patties were held overnight at 3 C. and reweighed to determine the "total-drip". Table 1 shows the drip losses obtained for grinding vs flake cut (FC) hamburger. The drip losses obtained for "thaw-drip" were less than 1 percent. The "total-drip" losses for both types of patties were less than 4 percent with the FC patties having significantly less drip. These results indicated that the moisture and juices were tightly bound in both types of patties and more so in those comminuted by flake cutting. Cooking loss was similar, 26 and 25 percent for both patties types whether prepared by grinding or flake cutting.

A trained panel analyzed both types of patties for appearance, flavor, doneness, texture, tenderness, chewiness, juiciness and greasiness (Table 2). The trained panel found no significant differences in appearance, flavor or doneness between cooked patties prepared by the two methods. They did find, however, that the patties differed significantly in all other characteristics. The ground meat had a finer texture whereas the flake-cut meat was coarser. The ground meat was more tender, less rubbery, more juicy and more greasy than the flake-cut meat. Previous studies showed that flake-cut meat had improved binding and cohesive properties which may explain why the panelists found flake-cut patties to have a coarser grind (texture).

Table 1. Effect of flake cutting and grinding on drip and cooking losses in 15 percent fat hamburger patties

Type of Patty	Thaw Drip[a] (%)	Total Drip[a] (%)	Cooking Loss[a] (%)
Flake-cut	0.88±0.23a	2.35±0.45a	25.02±0.62a
Ground	0.90±0.24a	3.34±0.49b	26.03±0.64a

[a]Mean – Std dev for 10 patties/trt. Values in each column followed by same letter are not significantly different ($P<0.05$).
Randall & Larmond, 1977, J. Food Sci., Vol. 42. p. 728.

Table 2. Mean values[a] for characteristics evaluated by trained panel

	Ground Patties[b]	Flaked Patties	SE
Appearance	4.5a	4.5a	0.14
Flavor	3.2a	3.2a	0.11
Doneness	4.1a	4.3a	0.08
Texture	2.4b	3.7a	0.28
Tenderness	4.3a	2.8b	0.24
Chewiness	2.6b	4.0a	0.21
Juiciness	3.9a	2.7b	0.19
Greasiness	3.1a	2.3b	0.15

[a]Each value is the mean of 80 observations on the scale 0-6.0. Higher value denotes greater intensity of the characteristic.
[b]Any two values in a line not followed by the same letter are significantly different at the 5% level.
Randall & Larmond, 1977, J. Food Sci., Vol. 42. p. 728.

Improved binding and cohesive properties could also account for the reduced tenderness and juiciness, increased chewiness and reduced greasiness of flake-cut patties. The results of this study indicated that some of the desirable charateristics, primarily those related to textural properties, produced by flake cutting contributed to a steak-like product which is not required in a beef patty. When patties are produced from flake-cut meat, close control of meat temperature, blade speed, and duration of blending are all important in controlling cohesion properties of the beef pattie.

Two additional trends in hamburger processing are worthy of note. These are the use of vegetable proteins as fresh meat extender and the pre-cooking, freezing, and reheating of ground beef patties. Bowers & Engler (1975) studied the effect of pre-cooking, frozen storage and reheating on eating quality, cooking loss, percentage of moisture and TBA Value (level of rancidity) of ground beef and beef-soy blends (15 and 30 percent soy). Table 3 shows that losses (including initial cooking and reheating) were affected signigicantly by both percentage of textured soy added and the heating treatment. Adding textured soy protein to ground beef decreased the cooking loss. It generally is thought that soy additives bind some of the moisture during the heating process causing the cooking loss to be reduced.

The percentage moisture (Table 3) was significantly less in the pure beef patties than in beef soy blend patties. Neither the amount of rehydrated soy added (15 or 30 percent) nor the reheating process affected moisture content.

Table 3. Means of cooking loss, chemical measurements of freshly cooled and cooked-reheated beef and beef-soy patties

Factor	Freshly Cooked			Cooked-reheated		
	0%Soy	15%Soy	30%Soy	0%Soy	15%Soy	30%Soy
Total cooking loss (Cooking × reheating)%	33.95a	29.94b	26.05c	43.06d	37.56e	31.33f
Total moisture	52.23a	54.93b	55.53b	50.50a	54.02b	55.81b
TBA value	0.371a	0.171b	0.141b	0.346a	0.119b	0.110b

[a]Change in letter represents statistical significance (P<0.01)
Bowers & Engler (1975), J. Food Sci., Vol. 40, p.624.

Table 4. Sensory evaluations of freshly cooked and cooked-reheated beef and beef soy patties

Factor	Freshly Cooked			Cooked-reheated		
	0%Soy	15%Soy	30%Soy	0%Soy	15%Soy	30%Soy
Sensory Evaluations						
Meaty:						
Aroma	4.0*	2.0b	1.5b	1.8b*	2.8b	1.4b
Flavor	5.0a**	2.4b	1.4b	3.5b**	2.4b	1.6b
Stale						
Aroma	2.2a	1.6a	1.6a	3.6b*	1.7a	1.9a
Flavor	1.6a	1.6a	1.6a	4.0b**	1.7a	1.6a
Cereal-like						
Aroma	1.4	4.4	4.9	1.0	4.5	5.4
Flavor	1.3	4.1	5.3	1.1	4.0	5.2
Juiciness	4.8a**	4.2a	4.1a	3.4b	3.8b	3.4b
Texture	3.5a**	4.5b	4.8b	4.0b	4.0b	4.6b
Overall acceptability	5.1a	3.4b	2.9b	3.6b	3.6b	2.6b

Intensity scale of 1 - 7
*P<0.05
**P<0.01
Bowers & Engler, 1975, J. Food Sci. Vol. 40. p. 624.

TBA Values determined as an indicator of oxidative rancidity showed that heating had no effect. However, beef-soy blends (15 or 30 percent) had significant but lower TBA Values than pure beef. The differences may be due to the antioxidant effect of soy or from less fat in the soy beef blend.

Sensory work provided in Table 4 showed that meaty aroma and flavor of freshly cooked beef patties was scored higher than reheated and freshly cooked beef-soy patties. Generally, meaty flavor and aroma decreased with increased soy. After frozen storage and reheating, beef and beef-soy blends differed less in meaty flavor and aroma than when patties were freshly cooked.

Stale flavor and aroma (Table 4) of reheated beef patties were greater than for the freshly cooked patties. Taste panel scores given to the freshly cooked patties indicated that practically no stale flavor or aroma was present.

Cereal-like flavor and aroma was more detectable as the amount of soy increased. Heating the ground beef had no effect on cereal-like flavor or aroma. Even though soy-beef blends contained more moisture than pure beef, adding soy did not affect juiciness. However, reheated patties were less juicy than freshly cooked patties. Based on overall acceptability, freshly cooked beef was more acceptable than any other product tested. As the level of soy increased, the less acceptable were freshly cooked reheated patties. However, the difference was significant in acceptability between reheated beef only when 30 percent soy was added. There was no significant difference in acceptability between reheated beef and freshly cooked beef-soy patties with either 15 or 30 percent soy.

The effects of cooking and heating on the fatty acid composition of foods have been reported by Janicki and Appledorf (1974). The increasing consumption of fast foods and the interest in lipids and their relationship to health justify a closer look at the lipid composition of franchise fast foods. The two most popular cooking methods used by hamburger franchises are broiling and grill frying. Microwave ovens are gaining in popularity in large scale feeding operations to reheat conventionally prepared foods and to thaw and warm precooked frozen foods (Keefe and Goldblith, 1973). The objectives of their study were to compare moisture, crude fat, cholesterol, and total fatty acid patterns of ground beef before and after cooking. In addition, the effect of microwave reheating of prebroiled, frozen ground beef patties was determined.

Heating methods and cooking periods used as treatments for the ground beef patties are shown in Table 5. No statistical differences in mean weights and percent yield were found between broiled and grill fried patties (Table 6). Raw beef patties cooked in a microwave oven showed lower weight, percentage yield, and weight of moisture than the broiled and grill fried patties. Meat patties that had been precooked by broiling, frozen, and then reheated in the microwave oven, weighed the least when compared to all other cooking procedures studied, thus having correspondingly the lowest percentage yield and moisture content. This lower yield would be expected since the patties in effect underwent two heating processes.

Mean values and standard deviations for the weight of crude fat and total cholesterol are given in Table 7. Method of cookery affected the fat content remaining in the cooked patties. The mean crude fat content was similar between the broiled and the grill fried beef patties and also between the broiled and the microwave reheated patties. The microwave cooked patties showed the greatest loss of crude fat. Decreases in the total cholesterol content were observed in all cooking treatments except the microwave oven when compared to the raw patties. The decrease, however, was not significantly different among cooking treatments.

The mean values for the fatty acids obtained from the ground beef patties for each treatment are presented in Table 8. Significant percent composition changes occurred in the C16, C18:1, and C18:2 fatty acids for all methods of cooking. The C16 fatty acid (palmitic) underwent the greatest percent loss

Table 5. Heating treatments and cooking times

Treatments	Cooking time
Raw	
Broiled	50 sec.
Grill frying	4 min.
Microwave	90 sec.[a]
Broiled-frozen-microwave	75 sec.[b]

[a]Two heating cycles of 45 sec. each.
[b]Two heating cycles 45 and 30 sec. respectively.
This cooking time does not include the broiling, only the microwave heating.
Janicki & Appledorf, 1974, J. Food Sci., Vol. 39, p. 715.

Table 6. Effect of cooking method on percent yield and composition of ground beef patties[a]

Treatment	Weight(gm)	Yield(%)	Moisture(g)
Raw	107.5±2.8a	100a	67.6±2.3a
Broiled	73.1±5.3b	67.4±4.6b	42.5±4.1b
Grill fried	73.3±3.7b	67.8±3.3b	42.4±3.4b
Microwave	64.6±2.5c	59.7±2.4c	36.2±2.2c
Broiled-frozen microwave	59.8±2.6d	55.3±2.6d	30.4±2.9d

[a]Mean ± STD. dev. for 12 patties/trt. Values in each column followed by the same letter are not significantly different (P<0.05).
Janicki & Appledorf, 1974, J. Food Sci., Vol. 39, p. 715.

Table 7. Effect of cooking method on composition of ground beef patties[a]

Treatment	Crude fat (gm)	Total cholesterol(mg)	Cholesterol/crude fat × 10^3
Raw	18.1±2.3a	77±11a	4.47±1.27c
Broiled	10.0±1.0bc	63±12b	6.36±1.37b
Grill fried	10.5±1.2b	62±14b	6.02±1.82b
Microwave	8.0±1.0d	70±17ab	9.03±2.64a
Broiled-frozen microwave	8.9⁺1.2c	61⁺11b	6.98±1.71b

[a]Mean ± STD. dev. for 12 patties/treatment. Values in each column followed by the same letter are not significantly different (P<0.05).
Janicki & Appledorf, 1974, J. Food Sci., Vol. 39, p. 715.

during cooking and was further reduced in the microwave reheated broiled, frozen patties. The percent of C18:1 and C18:2 fatty acids increased following all cooking treatments. The C18:1 (Oleic) and C18:2 (Linoleic) fatty acids are probably more intimately involved as structural components of phospolipids and are less likely to be lost as drip.

The ratio of unsaturated to saturated fatty acids increased during all cooking treatments. The microwave treated patties showed the largest ratio of unsaturated to saturated fatty acids.

Table 8. Effect of cooking method on relative percent fatty acid composition of total lipid extract

10	0.1	0.1	0.1	0.1	0.1
12	0.1	0.1	0.1	0.1	0.1
14	2.8	2.8	2.7	2.8	2.8
14:1	1.8	1.5	1.8	1.9	1.6
14:2	0.4	0.4	0.4	0.5	0.6
16	27.1	25.4*	25.9*	25.6*	23.8*
16:1	5.5	5.1	5.8	6.0	5.0
17	1.2	1.3	1.2	1.1	1.2
16:2	0.7	0.8	0.8	0.8	0.7
18	16.4	15.3	14.4	14.4	14.9
18:1	39.5	42.0*	42.0*	41.4*	42.5*
18:2	2.4	3.6*	2.7*	3.1*	4.0*
20	0.2	0.2	0.2	0.2	0.2
18:3	1.2	1.2	1.2	1.2	1.3
22	0.2	0.2	0.2	0.3	0.3
20:4	0.3	0.3	0.4	0.6	0.8
Sat	48.1	45.5	44.8	44.6	43.4
Unsat.	51.8	55.1	55.1	55.5	56.5
Unsat/sat	1.07	1.21*	1.23*	1.24*	1.30*

[a]Number identifies the chain length and number after colon signifies the number of double bonds.
*Significantly different from raw at 0.05 level.

The results of these studies indicated no nutritional advantage in terms of lipid composition between broiled and grilled ground beef patties. Microwave heating, however, produced a pattie with less crude fat than the two conventional cooking methods. However, the brown crust did not occur in patties heated by microwave alone due to the short cooking time and low surface temperature.