A Comparison of Microwave and Conventional Cookery of Ground Beef and Ribeye Steaks

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Introduction

Many factors are involved in the choice of cooking method. These include meat palatability, cooking loss, time, and energy savings. This study was designed to determine the effects of cooking methods, conventional vs. microwave, on the palatability of ground beef and ribeye steaks, and cooking losses and shear values associated with each. A further objective was to compare the effect of a dry, browning, tenderizing seasoning (Microshake^{R}*) on meat cooked in a microwave oven to that without it, and at the same time compare microwave cooked meat with conventionally cooked meat.

Research dealing with microwave cookery of meats has produced varying results where appearance, aroma, taste, and cooking losses are concerned (Apgar, et. al. [1]; Headley and Jacobson [3]). Studies conducted twenty years ago cannot take into account technological advances made in microwave ovens, cooking utensils for microwave ovens, and products enhancing microwave meat cookery developed to improve the quality of meat cooked in a microwave oven.

Experimental Procedure

Two lots of ground beef, obtained from a local market, were designated fat and lean. Preliminary tests for fat levels, conducted with a Hobart Fat Percentage Indicator, showed 12% fat in the leaner beef and 16% in the fatter beef.

Ground beef patties were prepared fresh. A portion of beef was weighed to 114 g., uniformly pressed in a Tupperware hamburger press and reweighed. Beef patties weighed, ready to cook, 114 g. ± 2.

Four cooking treatments were assigned for both fat levels - two conventional (con) methods: broil (br) and panfry (pf) and two microwave methods: microwave only (mw) and microwave with Microshake^{R} (Msk). Three beef patties were cooked simultaneously for each treatment, and each treatment was duplicated.

Microwave cooking treatments were conducted with a Litton 560 microwave oven, and broiling and panfrying were done with an electric range. Microwave cooking was conducted at the "high" power setting. Wattage output at this setting was determined by the rise in water temperature when 473 ml of distilled water is heated one minute. Using the formula: wattage = TC x 31.6, wattage output equals 495 watts (Van Zonte [5]). Panfrying was done in a 30 cm diameter stainless steel frying pan on the large element. The heat setting varied between medium and medium-high. Patties to be broiled were placed on a stainless steel grill 5 cm from the preheated element. All microwave treatments were cooked in a ribbed, plastic tray specifically designed for use in microwave ovens. The beef patties treated with Microshake^{R} were moistened with water, and the product was applied just prior to cooking.

Cooking times varied with both conventional and microwave treatments. All patties were cooked to the same degree of doneness (well done), which was determined visually by cutting a sample open (Cross, et. al. [2]). There was uneven cooking in both the conventional and microwave ovens. Untreated samples in the microwave oven were rotated twice in 2.5 minutes. Microshake^{R} treated patties were rotated three times in 4.5 minutes. Occasionally, a sample was returned for further cooking in both the conventional and microwave treatments. Cooking times with the electric oven were not accurately recorded but ranged from 10-12 minutes, both in the broiled and panfried treatments. All patties were weighed after cooking, and cooking losses determined. Two patties were sectioned into eight pieces (pie fashion) for sensory evaluation. The third sample was sheared on a Lee-Kramer shear press, and the sample blast frozen for proximate analysis.

Procedures for ribeye steak preparation were similar to those for beef patties. However, three cooking treatments were used: broil, microwave, and microwave with Microshake^{R}. Each treatment was duplicated, and cooking losses and shear values (Warner-Bratzler) were determined in addition to sensory evaluation.

Six deboned and defatted ribs were cut while frozen into 1.9 cm steaks (three steaks per rib) and thawed overnight at 0°C. The ribs utilized were selected on the basis of common marbling score: slight 80. In that animal differences could be expected to be a source of variation, the two trials were conducted in different manners. The first placed steaks from the same rib in the same treatment. The second distributed the steaks from the same rib among the three treatments.

Length of cooking time to the same degree of doneness varied widely among the steaks, particularly those cooked in the microwave oven. Individual steaks were returned two or three times to achieve the proper degree of doneness. Steaks cooked with Microshake^{R} required approximately 30% longer cooking time to reach the same degree of doneness as those cooked in a microwave without Microshake^{R}.

Sensory evaluation of the samples was conducted by a ten-member, untrained (consumer) panel (Cross, et. al. [2]). Six sessions were required to evaluate all samples, with a maximum of four samples per session. The samples were rated for tenderness, juiciness, flavor, and overall acceptability on an eight-point hedonic scale, with eight being the most favorable, and one being the least favorable rating.

*Microshake^{R} - a registered product of Microshake, Malibu, California.

Results and Discussion

Sensory Panel

Ground Beef - The mean scores for sensory evaluation are presented in Table 1. The highly significant person effect for each characteristic indicates that individuals in this untrained taste panel consistently ranked samples high or low relative to other panelists as would be expected. Among the conventional methods, panfried was scored higher ($P<.01$) than broiled in both juiciness and flavor. The microwave methods produced more tender ($P<.01$) ratings than conventional cooking. While there was little difference in acceptability between microwave and conventional cooking for the 16% fat beef, microwave cooking was preferred at the lower fat level ($P<.05$). There was a highly significant difference between the microwave and microwave using Microshake^{R} treatments for juiciness, flavor, tenderness, and overall acceptability. In each case, the Microshake^{R} was the preferred treatment.

Rib Steaks - There was a highly significant difference ($P<.01$) in flavor between the Microshake^{R} and the microwave treatments, Microshake^{R} preferred (Table 3). Person and person by cooking differences were significant sources of variation in flavor, juiciness, and overall acceptability.

Cooking Losses

Ground Beef - Although variations within individual treatment were high, certain trends were observed. The leaner beef had the least cooking loss. Broiling produced the greatest loss, and microwave with Microshake^{R} the least loss. Panfrying and microwave treatments were intermediate (Table 5).

Rib Steaks - Microwave with Microshake^{R} produced the least cooking loss; broiling and microwave about the same loss (Table 6).

Shear Values

Ground Beef - Microwave treatments had lower shear values than conventional treatments. Microshake^{R} treatments sheared more easily than microwave only, and panfried treatments sheared more easily than broiled (Table 5).

Rib Steaks - Microwave with Microshake^{R} sheared more easily than microwave or broiled (Table 6).

Proximate Analysis

Only ground beef samples were analyzed; mean values only were computed (Table 7).

Proximate analysis revealed that the uncooked ground beef samples designated 12% and 16% fat contained 13.25% and 18.75% fat, respectively. Although only two samples per treatment were analyzed, some interesting and unexpected trends were observed. The Microshake^{R} treatment was lower in percent fat than any of the other treatments. This was true for both the leaner and fatter ground beef samples. At the same time, the moisture values of the Microshake^{R} treatments were higher than any of the other treatments. Protein values were in the same range for all treatments; microwave only was slightly lower than the rest.

The low fat percent of the Microshake^{R} treatment does not correspond to the lower cooking loss, lower shear values, and significantly higher taste panel scores for tenderness, juiciness, flavor, and acceptability when compared to microwave only treatments. While the percent fat values are low, the values for moisture are high. The Microshake^{R} treatment exhibits the lowest fat value (10%) while showing the highest moisture value (59.63%). Part of this difference may be explained by the greater moisture content of lean tissue when compared to fat tissue. It may also be explained by the sampling procedure which utilized the sheared sample for proximate analysis, ie., some fat lost while shearing not included in analysis.

A further explanation may be the effect of the Microshake^{R} on the ground beef. Microshake^{R} contains salt and emulsifiers. Salt may influence (increase) the water-binding capacity of the lean tissue. The emulsifiers may enhance the rendering out of the fat fraction during cooking.

Certainly this was too small a sample on which to base any conclusions. It is obvious that more tests are necessary to determine the actual effect of Microshake^{R} on the fat and moisture fraction of ground beef.

Literature Cited

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Table 1

Mean Scores for Sensory Evaluation* of Ground Beef

	Tenderness		Juiciness		Flavor		Acceptability	
% Fat	12	16	12	16	12	16	12	16
Pan Fry (Pf)	5.95	5.45	4.95	4.85	5.60	5.55	5.40	5.55
Broil (Br)	5.60	5.35	4.20	4.30	4.90	5.00	4.90	5.05
Microwave (Mw)	5.85	5.05	4.05	4.00	4.60	4.30	4.95	4.50
Microshake[R] (Msk)	6.50	6.15	5.85	5.20	6.40	5.90	6.40	5.50

*8 = most desirable; 1 = least desirable.

Table 3

Mean Scores for Sensory Evaluation of Ribsteaks

	Tenderness	Juiciness	Flavor	Acceptability
Broiled	4.65	5.35	4.90	5.10
Microwave	5.60	5.00	4.50	5.15
Microshake[R]	5.65	5.35	6.15	6.15

Table 2

Analysis of Variance of Sensory Evaluation of Ground Beef

Source of Variation	df	Tenderness	Juiciness	Flavor	Acceptability
		MS	MS	MS	MS
% Fat (%)[a]	1	7.23	.87	1.41	1.41
Cooking (C)[b]	(3)				
Con. vs. Mw[c]	1	4.90**	3.64	.06	1.41
Mw vs. Msk[d]	1	15.31**	38.92**	57.80**	37.81**
Pf vs. Br[e]	1	.31	10.08**	7.81**	5.00
% x C[f]	(3)				
Con. vs. Mw	1	.90	4.83	1.81	4.56*
Mw vs. Msk	1	1.01	2.38	.20	.11
Pf vs. Br	1	.01	.07	.11	.01
Person[g]	9	2.19**	7.37**	5.55**	5.60**
Person x %[g]	9	1.25	.74	.71	.64
Person x C[g]	27	.41	1.03	1.02	1.38
Person x C x %[g]	27	.30	3.16	.62	.64
Within	80	.63	2.33	.81	1.39

* P<.05
**P<.01

a. Error mean square = Person x %
b. Error mean square = Person x C
c. Conventional cooking vs. microwave cooking
d. Microwave vs. microwave using Microshake[R]
e. Pan fried vs. broiled
f. Error mean square = Person x % x C
g. Error mean square = within

Table 4

Analysis of Variance for Sensory Evaluation of Ribsteaks

Source of Variation	df	Tenderness	Juiciness	Flavor	Acceptability
		MS	MS	MS	MS
Cooking (C)[a]	(2)				
Con. vs. Mw[b]	1	12.68	.41	2.41	3.01
Mw vs. Msk[c]	1	.03	1.28	27.23**	11.03
Person[d]	9	2.55	2.39*	3.60**	.47
Person x C[d]	18	1.38	2.11*	1.19	3.59**
Within	30	1.60	.95	.85	.97

* $P<.05$
**$P<.01$

a. Error mean square = Person x C
b. Conventional cooking (broiled) vs. microwave cooking
c. Microwave vs. microwave using Microshake[R]
d. Error mean square = within

Table 6

Mean Values for Effects of Cooking Method on Cooking Losses and Shear Values - Rib Steaks

Treatment	Cooking Loss (%)	Shear Values (W/B)*
Broil (Br)	28.4	15.25
Microwave (Mw)	28.9	14.10
Microwave with Microshake[R] (Msk)	23.7	10.6

*lower number preferred

Table 5

Mean Values for Effects of Cooking Method on Cooking Losses and Shear Values - Ground Beef

Treatment	Cooking Loss (%)		Shear Values (Lee-Kramer)*	
% Fat	12%	16%	12%	16%
Panfry (Pf)	24.7	30.0	.0222	.0197
Broil (Br)	31.1	32.9	.0203	.0220
Microwave (Mw)	24.5	27.0	.0178	.0214
Microwave with Microshake[R] (Msk)	21.1	26.6	.0149	.0174

*lower number preferred

Table 7

PROXIMATE ANALYSIS OF MEAT SAMPLES

Mean Values (Percent) for Protein, Moisture and Fat of Ground Beef

	Protein		H_2O		Fat	
% Fat	12%	16%	12%	16%	12%	16%
Pf	28.19	27.80	56.50	53.44	13.38	16.61
Br	28.56	27.35	52.25	53.38	10.88	17.44
Mw	26.13	25.69	56.63	54.32	14.13	16.88
Msk	27.44	28.32	59.63	55.50	10.00	14.94
Control - uncooked	20.81	20.31	64.75	60.63	13.25	18.75