

New Approaches and Methods for Microwave Cooking of Meat

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Experiments involving cooking meat in microwave ovens at the National Live Stock and Meat Board are based on the premise that a growing number of consumers wish to use a microwave oven for cooking meat, including the primary cooking of meat. The number of households owning microwave ovens is constantly increasing and the current saturation is 23 percent. In addition, a microwave oven is high on the list of appliances that consumers say they plan to buy.

Surveys indicate that an increasing number of people who own microwave ovens cook meat in them, although many are dissatisfied with the results they obtain. Meat is basic to so many meals that consumers are eager to get results they consider satisfactory when microwaving different meats.

Finding the most satisfactory way of microwaving a variety of meat cuts has been the aim of work conducted in the Meat Board kitchens. Efforts have been directed toward developing techniques and formulating recipes and directions for microwave cookery that will provide optimum eating quality with different meat cuts.

The introduction of microwave ovens with variable power settings made many more meat preparations possible with little, if any, reduction in quality standards for the final product. Meat can be cooked satisfactorily in a microwave oven, but only when appropriate meat cuts are selected and a variety of preparation techniques are employed.

In evaluating meats cooked by conventional methods, the following factors of acceptability are used: appearance, aroma, tenderness, juiciness and flavor. These same factors are used in judging meat cooked by microwaves. The appearance of the entire meat cut is judged. The tenderness and juiciness of the different muscles of which a cut is composed and of meat in both the center and outer circumference of the cut are evaluated.

Cooking Meat Roasts in Microwave Ovens

The initial work at the Meat Board was with tender meat roasts — beef, pork and lamb. At the conclusion of this study,

recommendations were made for the selection of roasts and directions for microwaving them.

Three microwave ovens with variable power options were used. Both gas and electric ranges were used for the conventionally cooked roasts. Microwave power level comparisons were made on the basis of: high — 100 percent power (approximately 650 watts); medium — 50 percent power (approximately 325 watts) and low — 30 percent power (approximately 200 watts).

Top round roasts weighing approximately 3¾ pounds were cooked at these three different power levels and in a conventional oven at 325°F. The internal temperatures (after standing time of 15 minutes) ranged between 140°F. and 145°F. as recorded in the center of the roasts. Cooking losses were calculated and the roasts were cut through the center and evaluated. The conventionally cooked roast showed uniformity of doneness. The appearance was excellent and it was tender and juicy. In contrast, the roasts cooked in microwave ovens at high were not uniformly done. Meat in the outer portion was cooked considerably past well done and was neither tender nor juicy. There was a marked differentiation between where the meat was cooked by microwaves and the center which was cooked by conduction of heat from this outer area. Only the inner portion was tender and juicy.

The roasts cooked at medium power also showed contrast between the center portion and the outer circumference of the roast. More uniformity of doneness was attained when a low power setting (200 watts) was used. Speed was sacrificed, but the cooking losses were lower and the roasts were judged most acceptable.

Comparable results were obtained by cooking 3-rib beef rib roasts, cut from the small end of the rib. At rare (140°F.) the conventionally cooked roast was uniformly done. In the roasts microwaved at full power, extreme differences in doneness were noted between the center of the roasts (especially near the bone) and the edge portions. This difference was less pronounced with roasts microwaved at medium (325 watts). At low (200 watts) even more uniformity was attained, cooking losses decreased and scores were higher for juiciness and tenderness.

Boneless pork loin roasts were also prepared by conventional roasting and in microwave ovens. These were boneless double loin roasts, weighing approximately 3½ pounds. The roasts were cooked to an internal temperature of 170°F. at the lowest of three points in the roasts. No pink color was noted in any of the roasts. The pork roasts microwaved at high required

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less than $\frac{1}{3}$ the time required for conventional roasting. The cooking loss was almost twice that of the conventional roasts and the roasts were dry, less juicy and less tender. Much more satisfactory results in terms of palatability were obtained at medium and low power settings. As the power was cut back, cooking losses were reduced and cooking time increased. Although microwave cooking at low took longer than at medium or high, it saved considerable time over conventional roasting.

A more extensive study was done with beef top round roasts, weighing $3\frac{1}{2}$ to 4 pounds with a diameter of $3\frac{1}{2}$ to 4 inches. This is an ideal roast in size and shape for microwaving. The roasts were prepared by cutting the portion of the top round behind the aitch bone in three parallel equal portions and tying. Similar roasts were cooked at the three established wattages and conventionally. Cooking times and losses were calculated and charted.

Beef Top Round Roasts ($3\frac{1}{2}$ to 4 pounds)

Approx. Watts	Min. Per Pound	% Loss
650	$8\frac{1}{2}$ - $9\frac{1}{2}$ *	28 - 31
325	11 - 13 *	22 - 26
200	19 - 21 *	14 - 22
Conventional Oven		
(325°F.)	24 - 30**	10 - 16

*Internal Temperature: 145°F. to 150°F.

**Internal Temperature: 140°F.

As a result of these experiments, the following recommendations for microwaving tender meat roasts were drawn up:

Recommendations for Microwaving Tender Roasts

1. Place roast on rack in microwave-safe dish.
2. Do not add liquid.
3. Do not cover. Do place wax paper over top of the roast.
4. Use low power (200 watts).
5. Invert roast during cooking. First fat side down; then fat side up.
6. Rotate dish during cooking . . . for uniformity of doneness.
7. Shield specific areas with small amount of foil.
8. Use a microwave thermometer or temperature probe during cooking or a quick recovery or regular meat thermometer after the roast has been removed from the microwave oven.
9. Allow standing time. Tent roast with foil.
10. Allow for temperature rise. The amount of rise in temperature upon standing depends upon the power at which the meat was cooked. In general, roasts rise 15 to 20 degrees when cooked on high; about 10 degrees on medium and 5 degrees on low.

Selecting Microwave Roasts

Actually, success with microwaving roasts begins before the application of power. It starts with the selection of the meat. Tender, boneless cuts that are compact and uniform in shape make the best choices. Ideally suited are roasts weighing 3 to 4 pounds and tied into a compact roll. The following beef, pork and lamb cuts are good choices for microwaving as roasts:

Beef Roasts

- Boneless:** Top Round Roast
Tip Roast (cap off)
Rump Roast
Rib Eye Roast
Top Loin Roast
Tenderloin
- Bone-In:** Rib Roast (small end)

Pork Roasts

- Boneless:** Top Loin
Top Loin (double)
Smoked Ham
Canned Ham
Canadian-Style Bacon
- Bone-In:** Center Ham Slice
($1\frac{1}{2}$ in. to 2 in. thick)
Smoked Loin

Lamb Roasts

- Boneless:** Leg Roast
Loin Roast (double)
- Bone-In:** Center Leg Roast
Shank Half
Rib Roast

Braising Pot Roasts in Microwave Ovens

This study involved cooking beef chuck pot roasts (bone-in arm and blade and boneless blade and shoulder) cut $1\frac{1}{2}$ to 2 inches thick, and weighing 2 to $3\frac{1}{2}$ pounds. Both frozen and fresh pot roasts were placed in cooking bags and microwaved at 30 percent power (approximately 200 watts) to an internal temperature of 205°F. to 215°F. (after 15 minutes standing time). Prior to cooking, the pot roasts were dredged in a seasoned flour mixture which included crushed instant beef bouillon granules.

This seasoning mixture was used to intensify the flavor of the cooking liquid which was served (thickened if desired) with the carved pot roast (as is customary with conventionally braised pot roasts). The aroma produced by moist heat cookery in a microwave oven is not as appealing as that produced by conventional braising. This observation also had been made by previous researchers. It was primarily to improve or cover the aroma, and also to flavor the cooking liquid, that a sliced onion was placed in each cooking bag atop the meat. The cooking bags were loosely tied with a $\frac{1}{2}$ -inch strip cut from the open end of the bag. Space was allowed for venting at the end when tying the bags.

As a result of these experiments, the following recom-

recommendations for microwaving frozen and fresh beef chuck arm, blade and shoulder pot roasts (1¾ to 3½ pounds) were drawn up:

1. Prepare seasoning mix by thoroughly combining ¼ cup crushed instant beef bouillon, 2 tablespoons flour, 1 teaspoon paprika and ½ teaspoon pepper.
2. Sprinkle seasoning mix, 1 tablespoon per side, over pot roast. Rub in gently.
3. Place pot roast (frozen or fresh) in a cooking bag in a microwave-safe utility dish.*
4. Add ¼ cup water and 1 sliced onion, if desired.
5. Close bag loosely with a ½-inch strip cut from open end of bag, allowing for venting.
6. Cook at 30% power (approximately 200 watts).
7. Turn pot roast 2 or 3 times during cooking.
8. Rotate dish during cooking.
9. Allow approximately 33 to 39 minutes per pound for frozen arm pot roasts, 29 to 35 for frozen bone-in blade roasts, 38 to 45 for frozen boneless blade roasts and 47 to 54 for frozen boneless shoulder pot roasts. Subtract 5 to 7 minutes per pound to make time estimates for fresh pot roasts.
10. Allow 10 to 15 minutes standing time in bag, before removing from bag and carving. Carve roast across the grain of meat. Serve cooking liquid with pot roast or first thicken if desired.

*Pot roasts also can be cooked in a utility dish covered with plastic wrap, a covered microwave-safe casserole dish or a simmer pot. Allow an additional 5 minutes cooking time per pound.

Will Meat Brown in a Microwave Oven?

Lack of the browning of meat cooked in microwave ovens is a factor that many consumers find undesirable. Browning is only a concern when cooking cuts that require only a short cooking time (steaks, chops and patties), for larger cuts require enough time to brown adequately. Browning can be achieved by the use of a special browning grill or platter inside the oven or browning in a conventional oven broiler or in a frying pan on a surface unit of a conventional range prior to microwaving meat cuts. Comparisons were made of surface browning and uniformity of doneness of conventionally broiled sirloin and top loin steaks with those cooked in microwave ovens at 50 percent power (approximately 325 watts) both with and without prebrowning. The surfaces of the steaks cooked in the microwave oven without prior browning were red (appearing raw), although the internal temperature of the steak reached 140°F. It is assumed that evaporation and the cool temperature of the air in the cavity of the oven kept the surface temperature low. Medium power produced somewhat better results, but the steaks scored low on appearance and were not uniformly cooked. The appearance was improved by prebrowning in a frying pan on the surface of a conventional range. More uniform cooking throughout was also noted. Similar results were obtained with top loin steaks using a browning dish prior to microwaving at medium power.

Rib and loin pork chops, cut 1 inch thick, were cooked with and without prebrowning. Virtually no browning of the surface was obtained when the chops were microwaved at medium without prebrowning. Considerable contraction of the muscle

was noted. Appearance and flavor development were improved when the chops were prebrowned in a browning dish in a microwave oven before completing the microwave preparation.

Disadvantages of prebrowning include the extra time required for the browning dish or platter to preheat and the extra energy expended for this preheating. In the case of prebrowning in a conventional frying pan, the additional disadvantage of the use of two cooking utensils was noted. Even so, the results in terms of product would indicate that prebrowning is worthwhile if consumers wish to microwave steaks and chops.

Promoting Browning of Beef Patties

This project involved formulating directions for obtaining a successful product when cooking beef patties in microwave ovens. Consumer dissatisfaction focused on lack of browning, uneven cooking and overcooking. Preliminary testing indicated that reduction of power could not achieve the desired results, for the cooking time was too short to achieve browning at any power.

Other testing, suggested by published research, indicated that the use of a seasoning mix applied to the top of the patties might offer a solution to browning. A seasoning mix was developed, using cupboard shelf staples. This seasoning-browning mix is made by combining 2 tablespoons salt, 2 teaspoons flour, 1 teaspoon paprika and ¼ teaspoon pepper in a salt shaker. This amount will season 28 to 36 beef patties, since only ⅜ to ¼ teaspoon is used on each patty, depending on the size of the patty.

These amounts of seasonings are less than, or do not exceed, the amount of salt and pepper generally specified in recipes calling for combining ground beef with seasonings before patties or meat loaf are formed. The amounts can be adjusted to suit individual tastes. Also, a cook can personalize the seasoning mix by adding small amounts of spices such as chili powder, dry mustard, cumin or garlic powder.

Comparisons were made with other sprinkle-ons and sauces recommended for giving a brown appearance — soy sauce, Worcestershire sauce, browning sauce (Kitchen Bouquet), seasoned salt, a browning agent in a shaker (Micro-Shake), gravy mix and crushed evaporated milk granules. The Board's simple salt-flour-paprika-pepper mix rated highest with a test panel.

The sprinkle-ons rely, at least in part, on the attraction of the microwaves to the surface of the meat due to the salt. This somewhat retards the cooking of the patties and additional seconds are required for them to achieve the same doneness as untreated patties.

Following the development of the seasoning mix, work was done on achieving more uniform cooking throughout the beef patties. Regular ground beef, between 70 and 75 percent lean, was used. Tests included patties formed three and four to a pound of ground beef, shaped approximately ½ inch thick and 4½ inches in diameter. The 4-ounce patties were cooked individually, in pairs and in groups of four; the 5½-ounce patties were cooked individually, in pairs and in groups of three. After the patties were placed in the pyrex dishes in which they were to be cooked, a hole ¾ inch in diameter was formed in the center of each patty, making it a doughnut

shape. Waxed paper was placed over the patties before cooking.

In all cases high power was used since the quality was not noticeably impaired by this speedy cooking, unless patties are cooked too long. When two or more patties were cooked in the same dish, the individual patties were rotated one half turn (180°). When two or more patties were cooked at once, it was not necessary to invert them during cooking. However, it was necessary to invert patties cooked individually at about mid-point in cooking, and to turn them back to original position just prior to standing time after cooking.

Upon removal from the microwave oven, the patties were allowed to stand (leaving the waxed paper in place) for 1 to 2 minutes, depending upon the size of the patty. Although the patties appeared to be only partially cooked when removed from the oven, they continue cooking while standing. The internal temperature of the patties after standing time ranged between 145°F. and 160°F. It is impossible to pinpoint recommended cooking times for consumers because of differences in microwave ovens, in lean to fat ratios of ground beef and the initial temperature of the beef and the cooking dish.

As guidelines, to be modified by individual preferences and home tests, approximate cooking times (Table 1) are suggested by the Meat Board.

Microwaving Bacon

Obtaining consistently good results when microwaving bacon was the goal of this project. Five brands of bacon were cooked in three microwave ovens, each representing a different wattage — 625, 650, 700. Two, four and six slices of bacon were microwaved at one time. Each test was repeated several

times. Comparisons were made in terms of cooking loss, shrinkage (length and width of strips), cooking time and appearance.

Whether a cook places two, four or six slices of bacon on a microwave bacon rack or places them between paper toweling in a 11¼ x 7½-inch microwave-safe baking dish has little effect on the acceptability of the finished product. The surface of the bacon does appear dryer when cooking between toweling. This was considered desirable by some samplers, less desirable by others.

Use of a rack does have the advantage of allowing for the collection of the bacon drippings. A rack, however, is more difficult to clean than the dish.

When paper toweling was used, some slices of bacon stuck to it. This happened only with some brands of toweling and some brands of bacon. Therefore sticking can be controlled by product selection. The fat-soaked paper gets very hot, especially when several layers of bacon are cooked. Layering the bacon also resulted in more uneven cooking as well as more sticking. In spite of these disadvantages, some consumers felt that the convenience of cooking more bacon by layering and therefore having all slices done at the same time was worth this inconvenience.

Bacon should be covered with something to avoid splattering the inside of the oven. Either waxed paper or paper toweling is satisfactory. Do not use plastic wrap over bacon.

Cooking time was dependent upon several factors — primarily the wattage of the microwave oven and the brand of bacon. The often used recommendation of 1 minute per slice is a rough estimate at best. For example, most bacon cooked in a 700-watt oven, based upon this recommendation, was overdone, some even burned. Less time should be allowed when using ovens of this wattage. Time per slice was reduced

Table 1. Approximate Cooking Times for Beef Patties

<i>Size of Patties</i>	<i>No. of Patties Cooked at Once</i>	<i>Total Cook Time</i>	<i>Total Stand Time</i>	<i>Special Instructions</i>
4 oz	1	1 min & 15 sec	1 min	Invert after 45 sec cook time, invert to original position before stand time
4 oz	2	2 min & 30 sec	1 min	Rotate patties after 1 min cook time
4 oz	4	3 min & 30 sec	1 min	Rotate patties after 2 min cook time
5½ oz	1	1 min & 45 sec	2 min	Invert after 1 min cook time, invert to original position before stand time
5½ oz	2	3 min	2 min	Rotate patties after 1½ min cook time
5½ oz	3	4 min	2 min	Rotate patties after 2 min cook time

when four slices were cooked at once.

The other major factor affecting cooking time was brand of bacon. This is due to differences in weight of the slices and also differences in processing. Some differences were observed between packages of the same brand of bacon, but these were not as pronounced as between different brands. It was noted that bacon cooked in one layer between paper toweling cooked slightly more rapidly than when on a rack.

The results of the project indicated that there are several satisfactory ways to cook bacon, the best depending upon the preference of the cook and those at the table. Consistent product and procedure were important to obtaining consistent results.

Microwaving Ham

Since most hams merchandised today are fully-cooked, they require only heating to serving temperature. This is also true of canned hams. Although heating is done satisfactorily in a microwave oven, different results were noted when microwaving different amounts of ham. When microwaving hams over five pounds, the muscles may separate and pull apart and the outside portions may become dry before the center reaches serving temperature. Slicing a large ham and overlapping or stacking the slices in a microwave-safe dish speeds heating and results in juicy, tender slices that are attractive in appearance and ready to be served.

Hams under three pounds can be microwaved either whole or pre-sliced. The Board recommends use of 50 percent power (approximately 325 watts) — or 30 percent power (200 watts) for microwaving ham. The ham should be inverted midway during microwaving and the dish rotated several times. It is impossible to pinpoint the exact time required because of differences in both microwave ovens and in hams. The size and shape of the ham as well as the weight determine cooking time.

Ten to 15 minutes per pound at 50 percent power is generally required for hams weighing approximately three pounds, although canned hams may take slightly fewer minutes per pound, as will larger hams. It is advised that the cut surface be covered with plastic wrap and that the edges of the ham be shielded with foil if they show signs of drying.

Ten minutes standing time (with the ham tented with foil) is recommended before carving. The internal temperature usually rises no more than 5°F. during this time. The ham should attain a final internal temperature of 130°F.

For approximately 3 pounds ham that has been cut into slices ¼ inch thick, place slices in two equal stacks in microwave-safe baking dish. Add ¼ cup water; cover tightly with plastic wrap (venting 1 corner). Cook at 50 percent power (325 watts) for 25 to 28 minutes, rotating dish ¼ turn after each 7 minutes. Let stand 3 minutes before serving. Or slices can be cooked at high power in approximately half the time.

For approximately 1½ pounds ham that has been cut into slices ¼ inch thick, place overlapping slices in microwave-safe baking dish. Add ¼ cup water; cover tightly with plastic wrap (venting 1 corner). Cook at 50 percent power (325 watts) for 10 minutes, rotating dish ½ turn after 5 minutes. Or slices can be cooked at high power in approximately half the time.

Another satisfactory microwave choice is a thick ham slice (1½ to 2 inches) to cook and carve as a roast. Cover the cut

surface with either waxed paper or plastic wrap and microwave at 50 percent power. Thinner slices of ham (¾ to 1 inch thick) cut from bone-in or boneless hams also are appropriate for microwaving.

Microwave Meat Research Is Needed

Research in the area of microwave cookery of meat has been very helpful to us at the Meat Board. It has increased our understanding of cooking by microwaves, has suggested directions to pursue and has helped us in the solution of problems. We are indebted to all the researchers listed as references.

Some research projects are more helpful than others. Unfortunately some research is still based on using only full power when cooking meat, and some have used foodservice ovens with higher wattages without reference to those wattages. In other papers, oven wattage is not specified.

The portions of meat samples cooked are sometimes too small to yield results significant for making conclusions as to consumer use of the microwave oven for cooking meat. Some methods employed are not applicable.

Generally the weight of meat used is reported in literature, but often the dimensions are not, and the shape as well as the size of the meat has even more impact on the results in microwave than in conventional cookery. It is especially important in evaluation of microwave cookery that samples be taken from several areas of the meat cut.

More research is needed to achieve satisfactory results in microwaving a wide variety of meat cuts. We hope that it is forthcoming, for consumers need help in making microwaves work for meat.

References

- Baldwin, R.E. 1977. Microwave cookery for meats. *Reciprocal Meat Conf. Proc.* 30:131.
- Baldwin, R.E. and M. Brandon. 1973. Browning of meats cooked by microwaves. *Microwave Energy Applications Newsletter* 6:3.
- Baldwin, R.E., B.M. Korschgen and G.F. Krause. 1979. Comparison of sensitivity of microwave and conventional methods for meat cookery. *J. Food Sci.* 44:624.
- Baldwin, R.E. and M.S. Russell. 1971. Microwave cooking of pre-browned steaks. *Microwave Energy Applications Newsletter* 4(3):3.
- Bodrero, K.O., A.M. Pearson and W.T. Magee. 1980. Optimum cooking times for flavor development and evaluation of flavor quality of beef cooked by microwaves and conventional methods. *J. Food Sci.* 45:613.
- Copson, D.A., B.R. Neumann and A.L. Brody. 1955. Browning methods in microwave cooking. *J. Agr. and Food Chem.* 3(5):424.
- Drew, F. and K.S. Rhee. 1979. Microwave cookery of beef patties: Browning methods. *J. Amer. Dietet. A.* 74:652.
- Drew, F., K.S. Rhee and Z.L. Carpenter. 1980. Cooking at variable microwave power levels. *J. Am. Dietet. A.* 77:455.
- Gast, B., G.J. Seperich and R. Lytle. 1980. Beef preparation expectations as defined by microwave user survey . . . a marketing opportunity. *Food Tech.* 34(10):41.
- Harrison, D.L. Microwave vs. conventional cooking methods: Effects on food quality attributes. *Kansas Agricultural Experiment Station, Contrib. No.* 80-109J.
- Hines, R.D., C.B. Ramsey and T.L. Hoes. 1980. Effects of microwave cooking rate on palatability of pork loin chops. *J. Anim. Sci.* 50(3):446.
- Korschgen, B.M. and R.E. Baldwin. 1980. Comparison of methods of cooking beef roasts by microwaves. *J. Microwave Power* 15(3):169.

- Korschgen, B.M. and R.E. Baldwin. 1978. Moist-heat microwave and conventional cooking of round roasts of beef. *J. Microwave Power* 13:257.
- Korschgen, B.M., R.E. Baldwin and S. Snider. 1976. Quality factors in beef, pork and lamb cooked by microwave. *J. Am. Dietet. A.* 69:635.
- Kylen, A.M., B.H. McGrath, E.L. Hallmark and F.O. Van Duyne. 1964. Microwave and conventional cooking of meat: thiamin retention and palatability. *J. Am. Dietet. A.* 45:139.
- MacLeod, G. and B.M. Coppock. 1978. Sensory properties of the aroma of beef cooked conventionally and by microwave radiation. *J. Food Sci.* 43:145.
- Moore, L.J., D.L. Harrison and A.D. Dayton. 1980. Differences among top round steaks cooked by dry or moist heat in a conventional or a microwave oven. *J. Food Sci.* 45:777.
- Nykvist, W.E. and R.V. Decareau. 1976. Microwave meat roasting. *J. Microwave Power* 11:3.
- Ream, E.E., E.B. Wilcox, F.G. Taylor and J.A. Bennett. 1974. Tenderness of beef roasts. *J. Am. Dietet. A.* 65(2):155.
- Ruyack, D.F. and P.C. Paul. 1972. Conventional and microwave heating of beef: Use of plastic wrap. *Home Econ. Res. J.* 1:98.
- Traub, L. 1979. Microwave ovens: Who's using them and why. *Natl. Food Research* 6:24.
- Voris, H.H. and F.O. Van Duyne. 1979. Low wattage microwave cooking of top round roasts: energy consumption, thiamin content and palatability. *J. Food Sci.* 44:1447.