

Label Instructions and Cooking Times for Retail Frozen Ground Beef Patties

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SUMMARY

Cooking instructions on 37 retail packages of frozen ground beef patties were recorded at 16 retail stores in four western states. The labels of eleven packages contained suggested cooking times, which varied from 1.5 to 8 minutes per side for 113 g patties. Times required to cook frozen patties to 71.1°C were determined using consumer conditions, including a fry pan on an electric stove and a propane grill. Variables included initial temperature of the frozen patty, pre-heating of the fry pan, cooking temperature, and patty fat content. The patty internal temperature was measured with five beaded wire type K thermocouples (TC). The average time required to cook a frozen (-18°C) 113 g 20% fat ground beef patty to 71.1°C (as registered on all five TCs) was 7 min 39 s when the pan was pre-heated to 163°C (medium stove burner setting). Starting with a 20°C pan increased average cook time by 4 min. Starting with a -26°C patty did not significantly affect cook time. Patty cooking times on a propane grill were more variable than those in a fry pan on an electric stove. The cooking times suggested on labels of three of the packages would be inadequate to produce a safely cooked patty.

INTRODUCTION

Consumers have developed *Escherichia coli* O157:H7 infections from consumption of undercooked ground beef. The most well known case is that in which over 500 consumers became ill and four died in 1993 as a result of consuming undercooked ground beef patties at a fast food chain (5). In 2002, home preparation of *E. coli* O157:H7-contaminated ground beef sickened 28 consumers and caused a nationwide recall of 18.6 million lbs of fresh and frozen ground beef and beef trimmings (6). During 2007, there were 19 recalls of ground beef totaling over 30 million pounds, of which less than 3 million pounds was recovered (23). Outbreaks from *E. coli* O157:H7 are most commonly linked to beef; during the period 1990 to 2005, 56% of *E. coli* O157:H7 outbreaks were attributed to beef (8). Cases of consumer illness from ground beef consumption continue to be reported, with recent cases of illness associated with ground beef purchased at retail meat cases of a large midwest grocery chain (22).

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FIGURE 1. Teflon disk with thermocouples for measuring patty temperature.

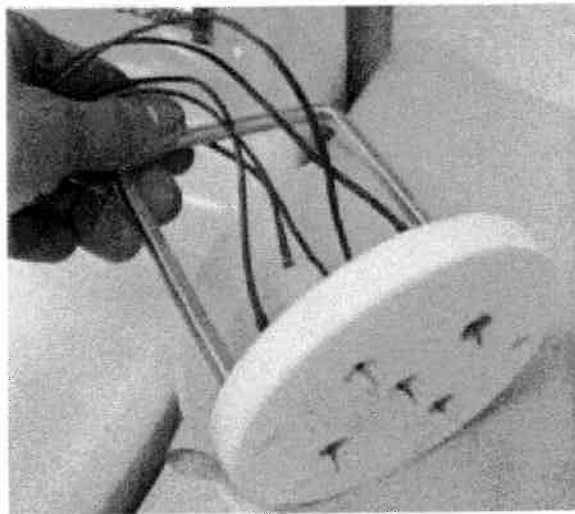






FIGURE 2. Safe handling instructions were displayed on all the observed packages of frozen ground patties, as required.

Safe Handling Instructions
This product was prepared from inspected and passed meat and/ or poultry. Some food products may contain bacteria that could cause illness if the product is mishandled or cooked improperly. For your protection, follow these safe handling instructions.

-  **Keep refrigerated or frozen. Thaw in refrigerator or microwave.**
-  **Keep raw meat and poultry separate from other foods. Wash working surfaces (including cutting boards), utensils, and hands after touching raw meat or poultry.**
-  **Cook thoroughly.**
-  **Keep hot foods hot. Refrigerate leftovers immediately or discard.**

Contracting an *E. coli* O157:H7 infection causes hospitalization in about 17% of cases, usually due to extreme diarrhea or kidney failure, and results in death in an estimated 0.5% of cases (17). *E. coli* O157:H7 infections are the leading cause of hemolytic uremic syndrome in children (19).

Destruction of pathogens that may be present in raw ground beef requires a cooking procedure that heats the beef to

an internal temperature of 160°F (24). Ground beef is made from 'beef trimmings' (12), which often include trim from the exterior of carcasses and which may carry pathogens. The process of grinding distributes any pathogens present throughout the meat. Although the presence of *E. coli* O157:H7 in ground beef was declared adulteration in 1994 (26), 0.23% of ground beef samples tested in 2007 by the Food Safety and

Inspection Service were positive for this pathogen (21).

Consumers are encouraged to use a food thermometer to determine that the internal temperature of ground beef patties they cook have reached 160°F (15, 20). Prior to 1997, consumers were encouraged to cook ground beef until "brown" in the middle to assure a safe temperature had been reached (14). However, research conducted in the 1990s determined that cooked ground beef color does not correlate to safe endpoint temperature (2, 9, 10, 14). The Food Safety and Inspection Service launched a national consumer education campaign to promote the use of food thermometers in the home in May, 2000 (27). Yet, the 2006 FDA/USDA Food Safety Survey of consumers indicated that only 13% of consumers always or often use a thermometer when cooking or grilling hamburgers (11) and an American Dietetics Association survey in 2002 indicated that 25% of consumers use a meat thermometer always or most of the time to check doneness for red meat, pork or poultry (7).

Ground beef patties are the most popular beef item for United States consumers; nearly 12 billion hamburgers were consumed by Americans in 2007 (3). Ground beef patties are the most frequently grilled meat (1). Frozen ground beef patties are convenient and popular; sales of frozen ground beef was almost \$336 million in 2007, with most being patties (4).

Since 1994, federal regulations require a Safe Handling Label, which includes information about storing, cooking, and avoiding cross contamination, on all consumer packages of ground beef (and other raw meat) (16). USDA approves the labels of meat and poultry products prior to market use. If cooking instructions are provided, it is expected that they will provide adequate information for consumers to prepare a safe cooked product (25). Furthermore, consumers should be able to expect the cooking instructions on packages of the frozen ground beef patties they purchase to be adequate to produce a safe, pathogen-free hamburger and to reflect current information about the preparation of ground beef patties. We surveyed label cooking instructions on packages of frozen raw ground beef patties and assessed the times required to cook the patties to the safe level of doneness when using several cooking parameters.

TABLE 1. Cooking time suggestions^a provided on labels of 11 packages of frozen, ground beef patties^b for various cook methods^c

Cooking Method	Minutes/side		Total cooking time Minutes (1 package each)
	Minutes	Number of packages	
Pan frying	8	2	13–14, turn every 3–4
	4	2	7–10
	4, then 2.5 to 3 ^d	1	
	3–4	1	
	2	1	
	1.5	2	
Grilling	9, then 3–4 ^d	1	11–12
	8	2	7–10
	4	2	
	3–4	1	
	3	1	
	1.5	2	
Broiling	7, then 2.5 ^d	1	15–16, turn halfway through time
	4	1	7–10

^aCooking time suggestions were either in minutes/side or total cook time.

^bPatty weight = 113 g.

^cNot all cook methods were provided on all packages.

^dIndicates number of minutes on one side, then a different number of minutes for the other side.

MATERIALS AND METHODS

For the survey of label cooking instructions, the label information on 37 unique packages of frozen ground beef patties was recorded, using a convenience sample of 16 grocery stores in four western states (WA, ID, CA, NV) over the period December 2006 to March 2007.

To assess the accuracy of package cooking times, several variables to simulate consumer practice were selected: frozen patty initial temperature (-18°C and -26°C), patty fat content (10%, 15%, and 20%), patty heating method, and cooking temperature (three settings). Frozen patties (113 g) were cooked, one at a time, turning the patty over every 2 minutes to facilitate even cooking (18). Two minutes was chosen as the turnover interval because juices began to pool on the surface of the patty at this time. Eight of 37 package labels suggested use of “pooling juices” as a cue for turning the patty over during cooking.

In experiment 1, the effects of three cooking temperatures and two methods (electric stove and propane grill) on cooking times were assessed. Each 20% fat, frozen patty (initial temperature -18°C) was cooked either in a pre-heated (3 min) 21-cm Teflon-coated aluminum fry pan on an electric stove at settings of medium-low (121°C), medium (163°C), or medium-high (204°C) or on a Weber model Genesis Silver propane grill pre-heated for 10 min, at settings of medium (approximately 254°C), medium-high (approximately 271°C), or high (approximately 332°C), with the grill cover closed during cooking (except when the patty was turned). A medium-low setting for this propane grill did not cook frozen patties in a reasonable amount of time. The cooking temperatures reported are for the surfaces of the fry pan and grill bars. The surface temperatures were determined using an infrared thermometer (Omegaette OS542, Omega Engineer-

ing Inc.); the grill bar temperature was verified by wiring a 0.25 mm wire glass-insulated type K thermocouple to the grill bar for some cook procedures. Grill bar temperatures varied much more widely than fry pan surface temperatures. Order of cooking was randomized within the cook method.

In experiment 2, the effects of fat content and patty starting temperature on cooking times were assessed when cooking was done on the electric stove and propane grill. Frozen patties of three fat contents (10%, 15% and 20%) and at two initial temperatures (-18°C and -26°C) were cooked in either a room temperature or preheated 21-cm Teflon-coated aluminum fry pan on an electric stove (medium setting) and on a preheated propane grill (medium-high). The preheating period was 3 min for the fry pan and 10 min for the grill. Order of cooking was randomized within the cook method.

TABLE 2. Mean cooking times^a required for frozen ground beef patties^b to reach 71.1°C when cooked at three heat settings using two methods of cooking^d

Electric Stove Setting (pan surface temperature)	3/5 TCs^c	4/5 TCs^c	5/5 TCs^c
Medium-low (121°C)	8:09 ± 0:15 A ^f	8:29 ± 0:27 A	9:14 ± 0:45 A
Medium (163°C)	6:35 ± 0:17 B	7:10 ± 0:40 B	7:39 ± 0:25 B
Medium-high (204°C)	6:25 ± 0:28 B	6:43 ± 0:49 B	7:00 ± 0:46 B
Propane Grill Setting (grill bar temperature)			
Medium (~254°C)	7:20 ± 1:17 A	7:38 ± 1:18 A	8:08 ± 1:27 A
Medium-high (~271°C)	6:17 ± 1:03 A	7:03 ± 1:53 A	7:35 ± 2:27 A
High (~332°C)	5:45 ± 1:16 A	6:02 ± 1:14 A	7:07 ± 1:42 A

^aMean cooking time = minutes:seconds ± standard deviation.

^bPatty weight = 113 g.

^cEndpoint temperatures were measured by five thermocouples (TCs) inserted to one-half of patty thickness.

^dMethods of cooking were pan-frying (pre-heated pan) on an electric stove and grilling on a preheated propane grill.

^eRepresents number of thermocouples out of a total of five registering 71.1°C.

^fTimes within a column and cook method followed by different letters are significantly different ($P < 0.05$).

Patty internal temperature was measured with five beaded wire type K thermocouples that were secured through a 10-cm diameter Teflon disk (13 mm thick) with a handle on top (Fig. 1). The thermocouples were located in the center of the disc and in each quadrant, equidistant from the center and the edge. The thermocouple bead was adjusted to protrude exactly 0.5 cm from the bottom of the disc, a distance that corresponded to one-half the diameter of the frozen ground beef patties. The Teflon disc was applied to the top of the cooking hamburger when two thermocouples had reached 71.1°C; this approximate time was determined in preliminary trials. Data was acquired using a Measurement Computing TC data logger and TracerDAQ software (Measurement Computing, Norton, MA). Times for 3, 4 and 5 thermocouples to reach 71.1°C were recorded. Five patties were cooked for each variable. Cook time data was discarded and the trial re-run if the temperature differential among the five thermocouples was greater than 10°C at the end of cooking.

Cooking time data for the patties cooked on the electric stove and pro-

pane grill in experiments 1 and 2 were analyzed using Analysis of Variance for a completely randomized design. The Fisher Least Significant Difference test was used for separation of means. All statistical inferences were deemed significant assuming a 95% level of confidence.

RESULTS

All of the 37 unique packages of frozen ground beef patties included in the survey, which represented 20 brand names, displayed the Safe Handling Instructions, as required by USDA (Fig. 2). Twenty-three of the packages instructed that the patties should be cooked from a frozen state, while the other packages did not address this point. Pre-heating of the pan and/or grill was recommended on 11 of the package labels. Cooking temperatures were suggested on 7 of the labels; use a “medium setting or 325°F” was most frequently recommended, but medium-low and medium-high were also mentioned (1 package each). Cooking times were suggested by 11 packages and varied from 1.5 minutes to 8 minutes per side for the 4-ounce patties (Table 1). Thirty of the packages included in-

structions to cook the patties to a specified temperature, 160°F on 23 packages and 165°F on 7 packages. Six of the 37 packages correctly stated that color was not an indicator of a safely cooked patty, but 5 incorrectly stated that the patty should be cooked until no longer pink. In addition, one package told consumers “Please do not overcook,” while another package stated “Do not undercook.” One brand (which had 6 unique packages in the survey) included a picture of the Thermy™ cartoon character, which was developed by FSIS to promote consumer thermometer use (27).

The results of experiment 1 to assess cooking times required at different heat settings (cooking temperatures) on an electric stove and a propane grill are shown in Table 2. When a frozen ground beef patty was cooked in a pre-heated frying pan, cooking times at the medium-low setting were significantly longer (roughly 1 to 2 min) than at the medium or medium-high settings, which were not significantly different from each other. On the electric stove for medium-low and medium settings, about 1 min longer was required for all 5 thermocouples to reach 71.1°C than for three thermocouples to

TABLE 3. Mean cooking times^a required for frozen ground beef patties^b containing three fat contents, or at two starting temperatures, to reach 71.1°C^c when cooked using two methods^d

Patty Fat Content (n = 20 for stove, n = 10 for grill)	Fry pan on electric stove at medium	Propane grill at medium-high
10% Fat	11:00 ± 2:48 A	8:07 ± 0:44 AB
15% Fat	9:03 ± 2:32 B	8:23 ± 0:46 A
20% Fat	9:53 ± 2:23 B	7:33 ± 0:38 B
Patty Starting Temperature (n = 30 for stove, n = 15 for grill)		
-18°C	9:50 ± 2:39 A	7:56 ± 0:47 A
-26°C	10:08 ± 2:44 A	8:06 ± 0:47 A
Pan Starting Temperature (n = 30)		
Room Temperature	12:11 ± 1:29 A	NA
Preheated 3 min	7:47 ± 1:27 B	

^aMean cooking time = minutes:seconds ± standard deviation.

^bPatty weight = 113 g.

^cEndpoint temperatures were measured by five thermocouples inserted to one-half of patty thickness, all reaching 71.1°C.

^dTimes within a column (cook method) and cook parameter (patty fat content, patty starting temperature, pan starting temperature) followed by different letters are significantly different ($P < 0.05$).

reach this temperature, and about 0.5 min longer was required for this to occur at the medium-high setting. For the propane grill, an additional 50 s to 1 min 20 s was required to fully cook the patty (all 5 TCs at 71.1°C) beyond the time required for 3 thermocouples to reach 71.1°C. For the propane grill, even though the trends of cooking times are similar to those achieved with the electric stove, there was no significant difference among the cooking times at the medium, medium-high and high settings due to the high variation among the five cooking replications. The difference in cook times within a replication of 5 patties cooked was as high as 4 min. The standard deviations for propane grill cooked patties were always larger than those cooked on the electric stove in experiment 1 (Table 2).

The results of experiment 2 to assess cooking times required for frozen patties of varying fat content and at two starting temperatures, when cooked in either a room temperature or preheated fry pan or on a propane grill, are shown in Table 3 (only the times for all five ther-

mocouples to reach 71.1°C are shown). The cooking times were significantly affected by patty fat content and by pan temperature, but not by patty starting temperature; there was no significant statistical interaction among treatments. The statistical analysis was conducted within each cooking method and parameter, and thus statistical comparisons across cooking methods or parameters cannot be inferred.

Frozen patties with a lower fat content (10%) required a significantly longer cooking time than those with 15% or 20% fat when cooked on an electric stove. For patties cooked on the propane grill, 15% fat patties had the longest cooking time, though not significantly different than 10% fat patties. Preheating the fry pan for 3 min before starting to cook frozen patties significantly shortened the cooking time, by over 4 min. The higher standard deviations for electric stove cooking times in experiment 2 is a result of the higher number of observations and cook parameters.

DISCUSSION

The store survey of package cooking instructions on labels of frozen ground beef patties revealed a wide range of cooking suggestions. It is useful that most of the packages (30 of 37) instructed consumers to cook ground beef patties to the USDA-recommended endpoint temperature of 160°F (71.1°C) or higher. However, since most consumers do not use a food thermometer to determine the doneness of ground beef patties (11), accurate cooking instructions are also needed. The wide range of recommended cooking times, 1.5 to 8 minutes per side for 113 g patties, and the conflicting information about the use of color to predict doneness of cooked meat and about avoiding both overcooking and undercooking, provide an array of confusing instructions for consumers who may buy a variety of package types when selecting frozen ground beef patties over time.

Our study to verify package cooking time recommendations using a variety of possible consumer practices indicated

that cooking times of less than 3 min/side would not produce a safely cooked product. Three package labels in the survey suggested cooking times of 1.5 to 2 min/side. For 20% fat patties on electric stove in a preheated pan, the longest total cooking time, 9 min 14 s, occurred at the medium-low setting. The shortest total cook time, 7 min, occurred at the medium-high setting, although this was not significantly different from the average of 7 min 39 s required at medium heat. Using a fry pan that is not preheated extends the cooking time by about 4 min (Table 3). For 20% fat patties on a preheated propane grill, the total cooking time required was 7 to 8 min (Table 2). The propane grill produced more variability in cook times than did a fry pan on the electric stove. Measurement of grill bar temperatures before cooking commenced showed variations of 40°C during repeated measurements due to the on-off cycling of the heat source. Variations in fry pan surface temperature were much lower, about 5°C. The variability of cooking times for patties, particularly when a propane grill is used, makes it difficult to accurately label cooking times. Under many cooking conditions, 4 or 5 min/side would be necessary to produce a safely cooked product.

Although the effect of patty fat content on cooking time was not consistent, the 10% fat patties cooked more slowly than those containing 15% or 20% fat on the electric stove. Others have reported longer cooking times when fat level was decreased in ground beef patties (2, 13).

In this work, five thermocouples were used to measure patty cooking temperature. All of the thermocouples did not reach the endpoint of 71.1°C at the same time (Table 2). In fact, after three thermocouples registered 71.1°C, an average of up to an additional min or more of cooking was required for thermocouples in all locations to register 71.1°C. Additionally, the lowest temperature is not always in the center of the patty, as has been previously observed (18). Although this work did not quantify post-cooking temperature rise in the patties, this rise has been well documented (2) and amounts to about 2° to 5°C, depending on patty size and cooking method. This effect reduces the likelihood of an under-

cooked patty resulting from measuring temperature in one location.

This study reveals that cooking instructions on some packages of frozen ground beef patties are inadequate to produce a safely cooked patty. The wide variations in cooking times, particularly for grilled patties, confirm that the use of a thermometer is the preferred method for assessing endpoint when cooking frozen ground beef patties. Package instructions should strongly encourage consumers to use an instant-read thermometer to cook patties to 160°F and indicate that patties should be checked in several locations. If cooking times are suggested on package labels, they should be described as guidelines as to when to check the internal patty temperature.

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RESULTS

These studies evaluated effects of time on the survival of *L. monocytogenes* on inoculated sponges held at 4°C for time periods of 0 (control), 24, 36, 48, or 72 h, as shown in Fig. 1. All four studies (three replications for each sampling time) indicated ample detection levels at all sampling times. Tukey-Kramer comparison of means indicated that there were no significant differences among the means during storage at the higher inoculation levels. However, there were significant differences among the means at the lowest (0.9 log) level of inoculation.

DISCUSSION

Results of these studies indicate that storing environmental sampling sponges at refrigerated temperatures (4°C) for up to 72 h does not adversely affect the survival of *L. monocytogenes* inoculated onto environmental sponges at less than 1 log up to 3 log CFU. The enhancement of *L. monocytogenes* replication, due to the addition of UVM enrichment broth and overnight incubation at 37°C, replenishes and aids in the survival of *L. monocytogenes* at low CFUs and therefore allows for valid positive/negative identification even at the lower inoculation levels (1 log CFU/ml). It was interesting that in all four studies, there was a slight drop in recovery of survivors at 36 h. We are assuming that this may be a reflection of the lag phase in *L. monocytogenes* replication. Although these studies encompassed holding times of only up to 72 h with no difference in the ability of

L. monocytogenes to replicate and survive under refrigerated conditions (8), it is possible that cells of *L. monocytogenes* may survive at 4°C on environmental sampling sponges past the 72 h time limit of these studies, although we do not have data to suggest this possibility.

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