

Time-Temperature Conditions of Gyros

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(Received for publication August 29, 1979)

ABSTRACT

Four gyro operations in foodservice establishments were examined for the possibility that pathogenic foodborne bacteria could survive and/or grow during each step of these operations. Gyros cooked on broilers attained temperatures lethal to vegetative pathogenic bacteria on the surface of the meat and in the thin layer just below the surface, but nowhere else. However, only meat sliced from the surface was normally put in gyro sandwiches or otherwise served. The temperatures of gyros as they cooled were such that bacterial growth could occur, both on the surfaces and within the mass. After gyros had been cooked and cooled, as many as 10,000 *Clostridium perfringens* per gram were recovered from samples taken just under the surface. Temperatures of gyro meat during reheating varied with the method of reheating, and they were in safe ranges when slices of meat were reheated in microwave ovens and steam chambers. When gyros were reheated on broilers, however, temperatures lethal to vegetative pathogenic bacteria occurred at and near the surfaces only. Recommendations for procedures to use for cooking, slicing, hot holding, cooling, and reheating gyros to prevent this product from becoming a vehicle of foodborne illness are given. Emphasis is on using the entire gyro the day it is originally cooked, rapid cooling of any leftover portions, and thorough reheating of leftover gyros.

A "gyro" is a meat dish or sandwich of either beef or lamb, or both, and often seasoned with onions, garlic, and parsley. The meat is either ground or sliced, and molded or stacked, often to form a frustum. The moisture and fat content of the mass causes the particles to cohere, particularly when frozen. Upon cooking, coagulation and other heat-induced processes provide even greater cohesion. The weight of gyros varies, usually within a 4.5- to 45-kg (10- to 100-lb) range; weights of 9 kg to 14 kg (20 to 30 lb) are common.

The frustum-shaped mass is impaled on a spit inserted along the vertical axis of symmetry. The spit is held vertically in an open broiler and rotates slowly as the gyro is heated. As slices of cooked meat are carved from the surface of the gyro, less-done surfaces are exposed which are in turn cooked more fully. The slices are usually characterized by a crusty exterior surface over a moist interior. They are frequently served as sandwiches in *pita* (bread) with a garnish of onion, parsley, lettuce and/or tomato and with a dressing of yogurt, sour cream or mustard.

Gyros or similar products are also called *yeros*, *dona kebabs*, *doner-kebabs*, *durno kebabs*, *dönnars*, *spelt dona*, *donah*, *chawarma*, *shawirma* and *souvlaki*. (The

term *souvlaki* also refers to cubes of meat that have been soaked in a marinade of oil, lemon juice and spices, put on a skewer and cooked on a grille or over an open flame.)

Various public health authorities have expressed concern about the microbiology of gyros during cooking, cooling and reheating (1,9). *Souvlaki* (gyro) has been alleged to be the vehicle of two small outbreaks in the United States (5,6). Meat products that are inadequately heated or reheated, improperly held hot or improperly cooled are often identified as vehicles of *Clostridium perfringens* gastroenteritis, salmonellosis or staphylococcal food poisoning (2).

The purpose of this investigation was to determine whether the temperatures of gyros during cooking, cooling and reheating in foodservice establishments constituted a potential for survival and multiplication of certain common foodborne pathogens.

METHODS

Temperatures of the surface and internal regions of gyros were determined during four routine operations in three foodservice establishments. In one of the establishments, temperatures were determined as a gyro was cooked, cooled and reheated in a manner to simulate certain conditions observed and reported by foodservice managers and health department officials, as well as their usual operation.

Operations evaluated

1. Ground-beef gyros, approximately 46 cm (11.5 inches) in diameter and 8 cm (3 inches) high, weighing approximately 4.5 kg (10 lb), were purchased frozen from a commercial source. The gyros were thawed by holding at room temperature for about 4 h and then put in a walk-in refrigerator. Thawed gyros were cooked in an oven and then tempered for a few hours at room temperature before cooling in a walk-in refrigerator. The next day the chilled gyro loaf was sliced in approximately 10-cm (4-inch) squares, and the slices were reheated in a hooded compartment of a steam table. Leftovers were stacked to a height of 10 cm (4 inches) in a pan, cooled in a one-door, reach-in refrigerator and on the next day again reheated in the steam table.

2. Gyros, approximately 14 cm (5.5 inches) in diameter and 23 cm (9 inches) long, weighing about 4.5 kg (10 lb), were molded of ground beef in the establishment and were not frozen. They were cooked by an open broiler by an electrically heated metal coil. A short time after cooking, they were cooled in a two-door, reach-in refrigerator. Slices were heated in a microwave oven when an order for a gyro was given.

3. Gyros, approximately 20 cm (8 inches) in diameter and 33 cm (13 inches) long, weighing about 11 kg (25 lb) were molded of ground beef in the establishment. The spit was inserted, and they were frozen in a walk-in freezer. Frozen gyros were cooked by a gas-heated, open broiler. At closing time, the remaining portion of the gyro was left on the spit and cooled in a 3-door, reach-in refrigerator. It was heated

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again by the broiler where it remained until sold. The last portion of a pound or two either fell or was cut from the spit. This was kept on a pan on a grille, and slices were heated on the grille when an order for a *gyro* was given.

4. A *gyro*, approximately 18 to 28 cm (7 to 11 inches) in diameter and 37 cm (14.5 inches) long, weighing 14 kg (31 lb), was purchased from the commercial source. It was cooked by a 3-element, electrically heated broiler. Leftovers were left on the spit and cooled in a walk-in refrigerator. The next day, the *gyro* was again heated by the broiler. Leftovers were again cooled in the refrigerator and reheated by the broiler the next day. During heating, one or more (and on some occasions all) of the heating units were turned off for various periods to prevent overheating the meat.

Temperature determinations

Type-T thermocouples were inserted into one of several 0.3-cm (1/8-inch) holes drilled vertically from the top to the middle of frozen *gyros* so that meat temperatures could be made near the geometric center and other internal locations. The distance down from the top is referred to in the figures as "deep," and the distance from the surface is referred to as "into." These thermocouples were thrust into the same region of unfrozen *gyros* or into cuts or cooked meat. Button-type probes were attached to external surfaces with wires or held against the surface by hand. Specific equipment and procedures were as previously described (4).

Laboratory procedures

Samples were aseptically collected with a sterile fork, after slicing the *gyro* with a sterile knife. They were put in sterile plastic bags, immediately refrigerated, and later iced and held in insulated containers for personal delivery to the laboratory.

The Tampa Branch Laboratory, Florida Department of Health and Rehabilitative Services, analyzed samples of raw and cooked *gyro* meat collected during this investigation by procedures that, other than where specified, followed the *Bacteriological Analytical Manual* (7).

Staphylococcus. Appropriate amounts of the homogenate and dilutions for a 3-tube MPN were enriched at 35 C for 48 h in trypticase soy broth (Difco) containing 10% NaCl. Broth from tubes showing evidence of microbial growth spread on tellurite polymyxin egg yolk (Difco) plates and incubated at 35 C for 48 h. Typical-appearing *S. aureus* colonies were picked and tested for coagulase.

Clostridium perfringens. One ml of the homogenate and appropriate dilutions to 10^{-4} were plated in sulfite polymyxin sulfadiazine agar (BBL) and incubated anaerobically at 35 C for 48 h. Suspected colonies were picked to tubes of fluid thioglycolate (Difco) which were incubated at 35 C for 24 h and then in a water bath at 46 C for 4 h. The culture was confirmed by streaking on liver-veal egg yolk agar (35 C for 24 h, anaerobic incubation), by tests for gelatinase motility and nitrate reduction and by staining.

Salmonella. Twenty-five grams of sample were added to 225 ml of lactose broth (Difco) and incubated at 37 C for 24 h. A loop of this culture was transferred to tetrathionate brilliant green broth (Difco) and incubated in the same fashion. The culture was streaked onto *Salmonella-Shigella* agar (Difco), MacConkey agar (Difco), brilliant green agar (BBL) and bismuth salt agar (Difco). The first three agars were incubated at 37 C for 24 h and the latter at the same temperature for 48 h. Suspect colonies were stabbed and streaked to triple sugar iron urea agar slant, which was incubated at 37 C for 24 h. Isolates were confirmed by testing for the presence of indole, fermentation of lactose and sucrose and decarboxylation of lysine. Poly O and group O slide agglutinations were also performed.

RESULTS

Thawing

Gyros were subjected to thawing procedures in only Operation 1. The day before cooking, the frozen meat was taken from a walk-in refrigerator and kept at room temperature for 4 h and then transferred back to the

refrigerator. When cooking commenced, the *gyro* had not yet thawed (Fig. 1).

Cooking

The *gyro* cooked in an oven like a meat loaf (Operation 1) reached temperatures throughout that would be lethal to vegetative pathogenic foodborne bacteria (Table 1, Fig. 2). The temperature of central internal regions increased after cooking during holding at room temperature before refrigeration.

The *gyros* cooked on broilers attained temperatures lethal to vegetative pathogenic foodborne bacteria only at the surface of the meat and in a thin layer just below the surface. Temperature data are presented in Table 1 and illustrated for Operation 2 in Fig. 3, for Operation 3 in Fig. 4 and for Operation 4 in Fig. 5.

Cooling

Temperatures of *gyros* during cooling were such that some bacterial growth could have occurred on surfaces and within the meat (Table 2, Fig. 6 and 7). Temperature data are presented in Table 2 and illustrated for Operation 1 in Fig. 6, for Operation 2 in Fig. 7, and for Operation 5 in Fig. 8 and 9. Cuts of meat, 10 cm (4 inches) or less in thickness, or slices stacked to that height, cooled rapidly enough to avoid the possibility of bacterial multiplication of an order great enough to cause foodborne disease (Table 2; Fig. 10).

Reheating

When a 10-cm (4-inch) high stack of slices of meat was reheated in a hooded steam-table chamber (Operation 1), the geometric center of the meat reached a temperature of 73.9 C (165 F) within 3 h (Fig. 11). During prolonged hot storage, the temperature of the meat varied with the temperature of the water in the steam table (Fig. 12). These data and data from other trials are summarized in Table 3.

The interior of a sandwich-size portion of this meat

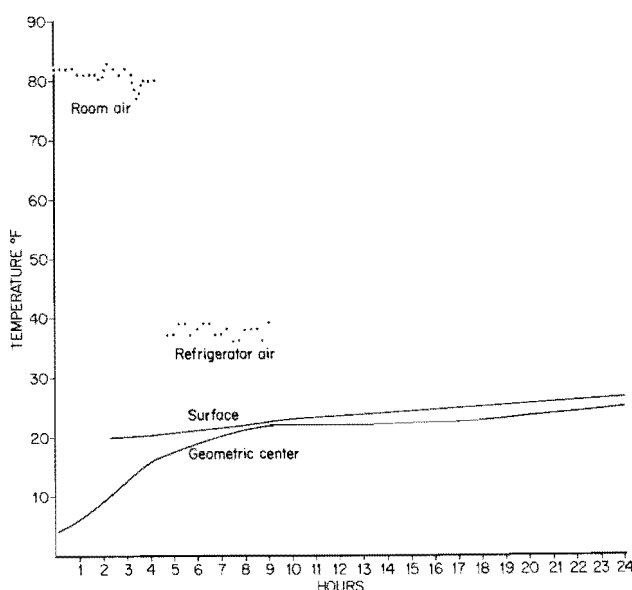


Figure 1. Temperatures of 9.5-pound gyro during thawing while held at room and refrigerator temperature (Operation 1).

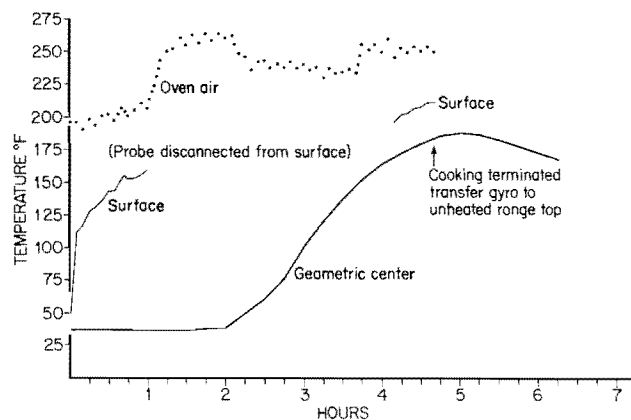


Figure 2. Temperatures of 9.5-pound gyro during heating in an oven (Operation 1).

reached a temperature greater than 93.3 C (200 F) during heating in a microwave oven (Operation 2; Fig. 13). During a second heating in gas or electrically heated broilers, the surfaces of gyros and a shallow layer below the surfaces attained temperatures that would be lethal to vegetative pathogenic foodborne bacteria. Temperature data are presented in Table 3 and illustrated for Operation 3 in Fig. 14 and for Operation 4 in Fig. 15 and 16. Other portions of the meat, however, did not attain lethal temperatures. Sandwich-size portions of meat, which were removed from the spit or carved from surfaces during times when the broiler was turned off, attained temperatures of 73.9 C (165 F) or higher when the meat was either heated on a grille (Fig. 17) or immersed in hot water (Fig. 18) long enough (Table 3).

Bacteriological analyses

Results of analyses of samples from three of the operations for the presence of *Salmonella* and the numbers of *C. perfringens* and *S. aureus* are given in Table 4.

TABLE 1. Times gyros were above certain temperatures during initial cooking.

Operation/weight (pounds)/ heat source	Probe location	Time in minutes at or above (F)								Expected survival of vegetative cells
		130	135	140	145	150	155	160	165	
1/9.5 pounds/oven	Surface	R ¹ /U ²	R/U	R/U	R/U	R/U	R/U	R/U	R/U	—
	Geometric center	77	72	68	63	58	52	46	40* ³	—
2/10 pounds/ hand-turned spit	Surface ⁴	R/U	R/U	R/U	0	0	0	0	0	+ / —
	1-1/2-inch beneath surface	0	0	0	0	0	0	0	0	+
	Geometric center	0	0	0	0	0	0	0	0	+
3/25 pounds/rotating spit, gas-heated gyro machine	Surface	R/U	R/U	R/U	R/U	R/U	R/U	R/U	R/U	—
	1/4-inch beneath surface	95	92	88	83	60	51	36	31	—
	Midway between surface and center	0	0	0	0	0	0	0	0	+
4/31 pounds/rotating spit, gas-heated gyro machine	Geometric center	0	0	0	0	0	0	0	0	+
	Surface	240	230	215	189	156	113	59	27*	—
	Midway between surface and middle probes, moved to near surface after 135 min	160	142	129	80	44	20	10	R	—
	Midway between surface and center	0	0	0	0	0	0	0	0	+
	Geometric center	0	0	0	0	0	0	0	0	+

¹R = Temperature attained.

²U = Time unrecorded.

³* = Time of storage at room-temperature and post-oven temperature rise not included.

⁴Surface temperature recording not continuous.

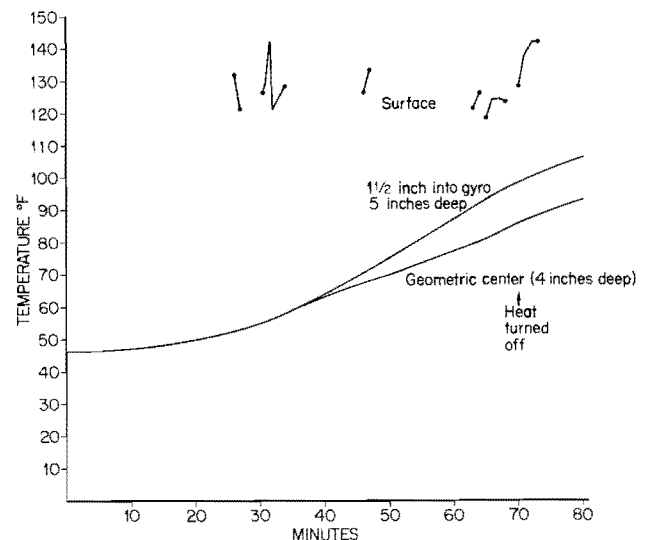


Figure 3. Temperatures of 10-pound gyro during cooking on an electrically heated gyro machine (Operation 2).

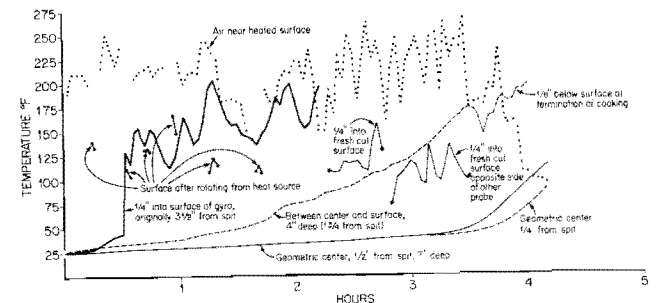


Figure 4. Temperatures of 25-pound, 5-ounce gyro during cooking on a gas-heated gyro machine (Operation 3).

DISCUSSION

Hazards attributed to temperatures of gyros during cooking, cooling and reheating differed somewhat among the operations. No significant growth of

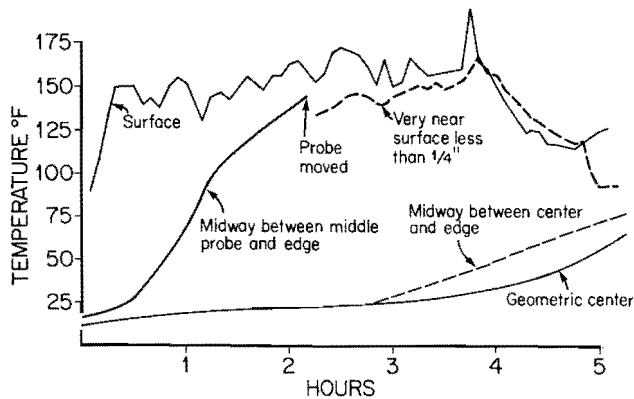


Figure 5. Temperatures of 31-pound gyro during heating on an electrically heated gyro machine (Operation 4).

pathogenic foodborne bacteria would be expected during the combination of room- and refrigerated-thawing used in Operation 1. In this operation, temperatures attained during cooking would have killed any vegetative pathogenic foodborne bacteria that were in the meat, but bacterial spores that survived cooking, and any bacteria that contaminated the meat as a result of carving or subsequent handling, could have multiplied during cooling. Subsequent reheating as observed (if continued long enough) would kill vegetative bacteria. Temperatures of the geometric centers of gyros during cooking, cooling and reheating are shown in Fig. 19.

In Operation 2, temperatures attained during cooking would have permitted any pathogenic foodborne bacteria present in most internal regions of the gyro to survive, and these organisms could have multiplied during cooling. These bacteria probably would have been killed during reheating in the microwave oven.

Temperatures reached in Operation 3 were sufficient to kill vegetative pathogenic foodborne bacteria on surfaces but not in most internal regions. All of the meat cooked in one trial was sold during cooking, so there was insufficient time for problems to occur. Although cooling was not evaluated it can be inferred from data on the other operations that certain bacteria present could have

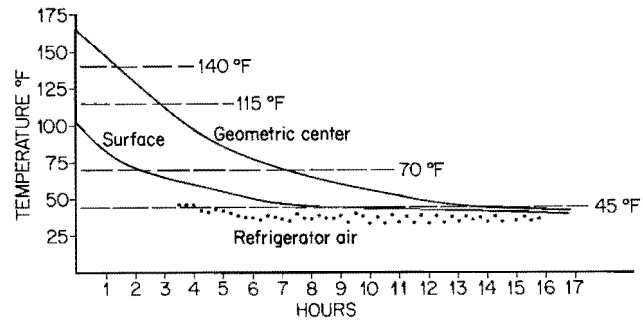


Figure 6. Temperatures of 9.5-pound cooked gyro during storage in a walk-in refrigerator (Operation 1).

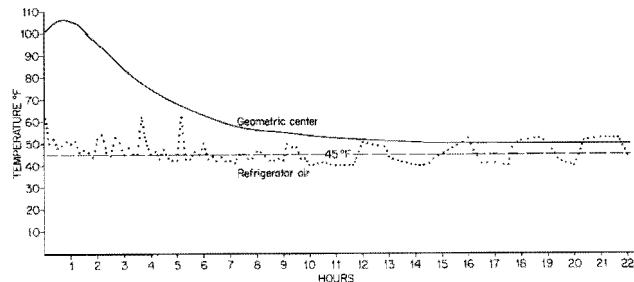


Figure 7. Temperatures of recently cooked 10-pound gyro during storage in reach-in refrigerator (Operation 2).

multiplied during storage in the refrigerator. Surfaces were reheated adequately.

The numerous problems that were observed in Operation 4 are indicated in Fig. 20. Temperature problems were seen in cooking during prolonged periods during which either the heat was turned down or off, or the gyro was moved away from the heat source. Considerable bacterial growth could also have occurred during the cooling period. Reheating was inadequate to kill vegetative bacteria in regions other than at or in shallow layers below the surface. Repeated cooling and reheating led to prolonged periods during which the temperatures of the interior regions were in a range within which bacteria could have multiplied rapidly.

Foodborne pathogens are present in raw or frozen gyro meat, as shown by Matossian and Kingcott (9) and data

TABLE 2. Times gyros were within certain temperature ranges during cooling.

Operation/weight or size	Probe location	Time in minutes between (F)				Expected growth
		85-115	70-115	60-122	45-140	
1/9.5 pounds	Surface	58	130	240	485	+
	Geometric center	130	260	395	755	++
1/4-inch pile	Geometric center ¹	45	65	105	215	-
2/10 pounds	Geometric center ¹	185	260	400	1320(+) ²	++
	Geometric center ¹	0 ²	35	105	900	(+) ³
4/21.5 pounds	Surface	58	143	267	660	+
	Midway between surface and middle probe	188	345	480	720(+)	+++
	Midway between surface and center	188	345	480	720(+)	+++
4/10 pounds, 13 ounces	Surface	88	174	240	540	++
	Geometric center	120	210	289	540	++
4/5.5 × 5 × 4-inch cut of meat	Surface	45	120	180	271	+
	1-1/2-inch beneath surface	88	153	215	283	+
	Geometric center	115	174	238	299	++

¹Multiple trials.

²(+) = Lower temperature of range was not reached at time food was removed from cooling unit.

³Cooling initiated before probe was inserted.

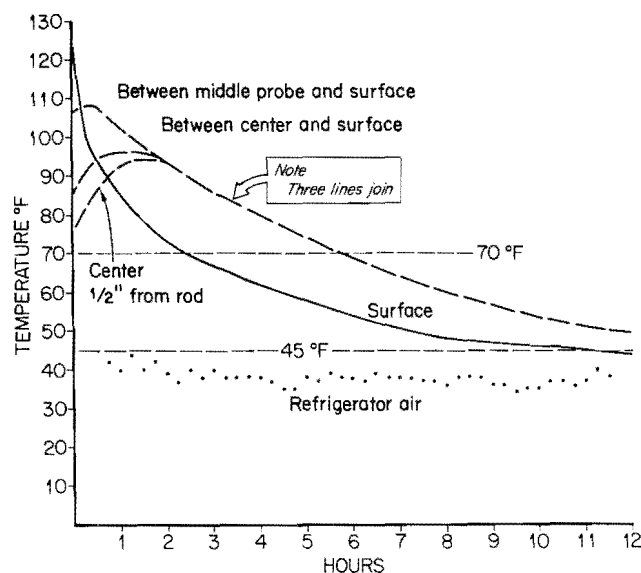


Figure 8. Temperatures of 21.5-pound previously heated gyro during storage in a walk-in refrigerator (Operation 4).

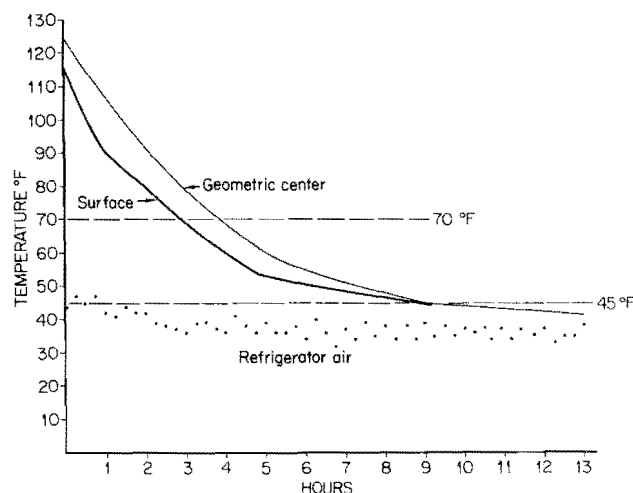


Figure 9. Temperatures of 10-pound, 13-ounce cooked gyro during storage in a walk-in refrigerator (Operation 4).

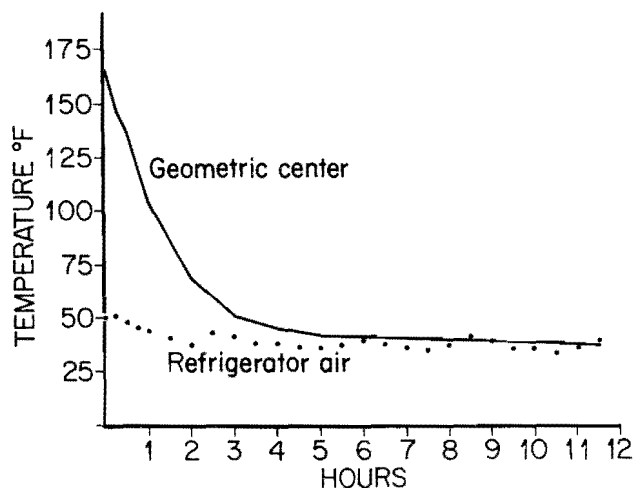


Figure 10. Temperatures of 4-inch pile of sliced cooked gyro meat during storage in a reach-in refrigerator (Operation 1).

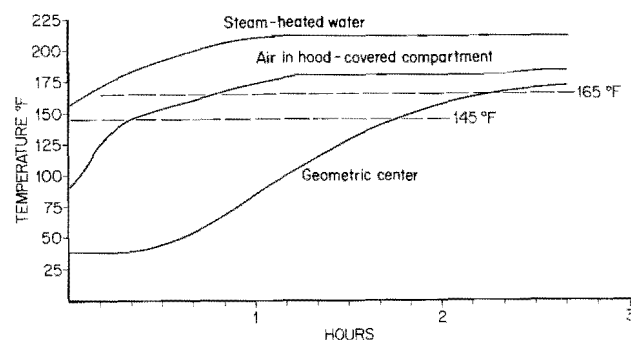


Figure 11. Temperatures of 4-inch pile of sliced cooked gyro meat during reheating in a hood-covered compartment of a steam table (Operation 1).

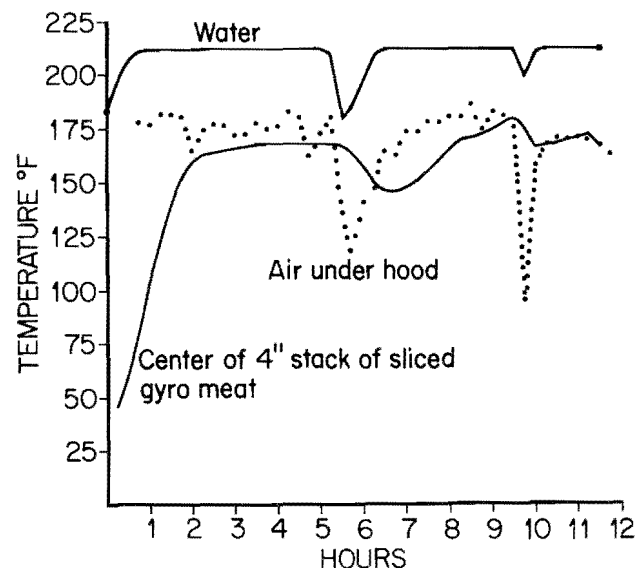


Figure 12. Temperatures of 4-inch pile of sliced cooked gyro meat during reheating and hot holding in a hood-covered compartment of a steam table (Operation 1).

in Table 4. During cooking, surfaces and shallow layers, approximately 0.6 to 1.3 cm (1/4 to 1/2 inch) in thickness, reached temperatures that were high enough and lasted long enough to kill pathogenic foodborne bacteria. According to Goodfellow and Brown (8) salmonellae would succumb in the geometric center of 4.5-kg (10-lb) or larger cuts of beef that were cooked in ovens at certain temperatures for sufficient time. If this conclusion is related to data observed during this investigation, salmonellae and organisms of similar ability to resist heat would be expected to survive in the geometric center and frequently in most other interior regions of the gyros during cooking, until these regions reached the surface as a result of carving off the outer portions. This hypothesis is supported by the observation of decreased staphylococcal counts on surfaces after cooking (Table 4).

Although sometimes there were long periods during which heat was turned off, surface temperatures increased again when the heat was turned on. The duration of the heating before serving, in conjunction with the temperature reached, would, however, not always have been sufficient to kill bacteria.

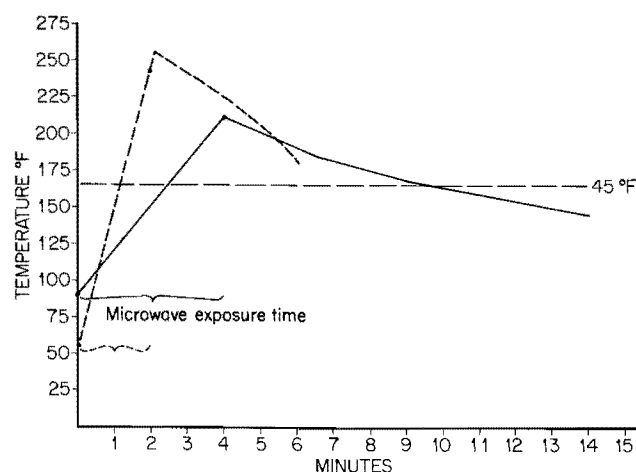


Figure 13. Temperature of slice of cooked gyro meat during reheating in a microwave oven. [Two trials presented by different line symbols; heating time and post-oven hold period also shown (Operation 2)].

There was considerable opportunity for bacterial growth in the interior regions of leftover gyro meat that was left on the spit during storage in refrigerators. Evidence of this happening was shown by the large numbers of *C. perfringens* found in chilled, cooked meat (Operation 4, Table 4). Also, Matossian and Kingcott (9) isolated heat-resistant strains of *C. perfringens* from 11 of 25 samples of cooked *chawarma*.

Although surfaces cooled more rapidly than interior regions, some bacterial growth could have occurred even on the surfaces. Cooling was more rapid when cooked

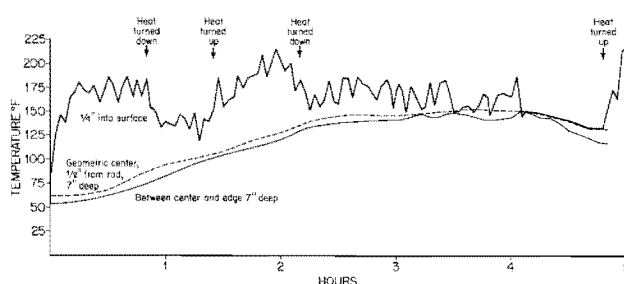


Figure 14. Temperatures of 14.5-pound, ground beef gyro during reheating on a gas-heated gyro machine after overnight refrigeration following initial cooking (Operation 3).

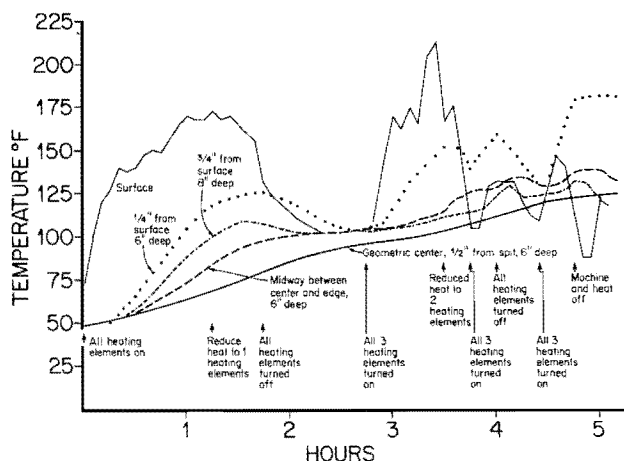


Figure 15. Temperatures of 21.5-pound previously heated and cooled gyro during reheating on an electrically heated gyro machine (Operation 4).

TABLE 3. Times gyros were above certain temperatures during reheating.

Operation/weight or size/heat source	Probe location	Time in minutes at or above (°F)								Expected survival of vegetative cells
		130	135	140	145	150	155	160	165	
1/4-inch pile/ hood-enclosed compartment of steam table	Geometric center ¹	95	87	80	71	62	49	33	18(+) ²	—
	Geometric center ¹	158	149	141	135	121	103	83	60(+)	—
	Geometric center ¹	69	61	60	54	49	43	34	23(+)	—
	Geometric center ¹	610	603	597	590	525	495	455	380(+)	—
2/slice of cooked gyro meat/microwave oven	Geometric center ¹	5.2 ³	5.2 ³	5.1 ³	5.0 ³	5.0 ³	4.9 ³	4.9 ³	4.8 ³	—
	Geometric center ¹	12.7 ³	12.6 ³	12.4 ³	12.2 ³	12.0 ³	9.8 ³	8.5 ³	7.1 ³	—
3/14.5 pounds/rotating spit, gas-heated gyro machine	Surface	294	279	264	238	218	195	174	161	—
	Midway between surface and center	140	126	100	45	2	0	0	0	—
	Geometric center	168	148	135	110	50	0	0	0	—
	Surface	157	144	128	116	110	94	83	70(+)	—
4/12.5 pounds/rotating spit, electrically heated gyro machine	1/4-inch beneath surface	124	108	98	86	66	47	32	30(+)	—
	3/4-inch beneath surface	18	0	0	0	0	0	0	0	+
	Midway between surface and center	70	30	0	0	0	0	0	0	+/-
	Geometric center	0	0	0	0	0	0	0	0	+
4/10 pounds, 13 ounces/rotating spit, electrically heated gyro machine	Surface	62	57	55	53	38	28	15	12(+)	—
	1/4 inch beneath surface	63	59	56	51	49	44	36	32(+)	—
	1/2 inch beneath surface	55	50	42	37	32	30	19	3(+)	—
	3/4 inch beneath surface	12	10	8	7	3	R ⁴	0	0	—
	1 inch beneath surface	0	0	0	0	0	0	0	0	+
	2 inches beneath surface	0	0	0	0	0	0	0	0	+
	Geometric center	0	0	0	0	0	0	0	0	+
4/slice/dipped into hot water	Geometric center ¹	2.7	2.5	2.3	2.1	2.0	1.7	1.3	0.5	—
	Geometric center ¹	2.5	2.3	2.1	2.0	1.8	1.5	1.2	0.9	—
4/slice/grille	Geometric center	1.9	0.9	0.8	0.7	0.6	0.5	0.4	0.3	—
3/slice/grille	Geometric center	1.9	1.6	1.4	1.3	1.1	0.9	0.6	0.3	—

¹Multiple trials.

²(+) = Time of storage of portions of meat sometimes exceeded this period.

³Data include post-oven temperature rise.

⁴R = Temperature reached.

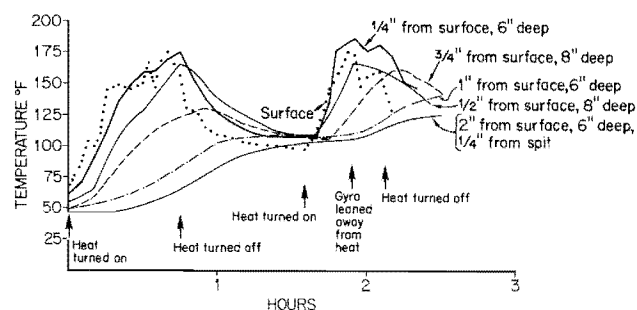


Figure 16. Temperatures of 10-pound, 13-ounce previously heated and cooled gyro meat during reheating in an electrically heated gyro machine (Operation 4).

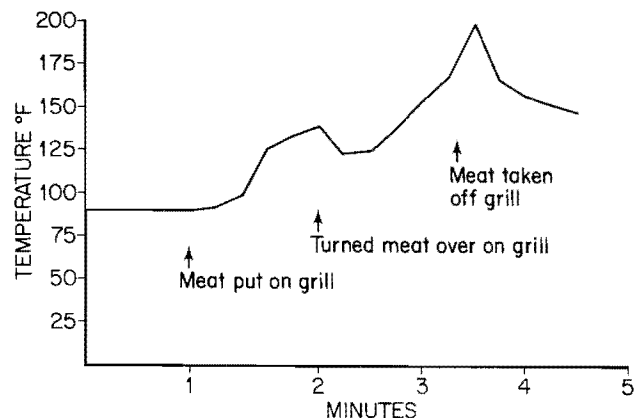


Figure 17. Internal temperatures of sandwich-size portion of gyro meat during heating on a grill after meat removed from gyro machine (Operation 3).

meat was cut or sliced from the spit and stored either in 10-cm (4-inch) high stacks or in cuts not larger than 10 cm (4 inches) in any dimension.

It is presumed that the temperatures reached at and near the surface during reheating of cooled gyro meat would have killed any vegetative pathogenic foodborne bacteria present in these regions. The temperatures would not, however, rise to levels lethal to this type of bacteria in the interior regions, such as that which fell or were removed from the spit at the termination of heating. The isolation of large numbers of *C. perfringens* and *S. aureus* from the interior of gyros after the cooking-cooling cycle, or subsequent reheating, cooling, and reheating

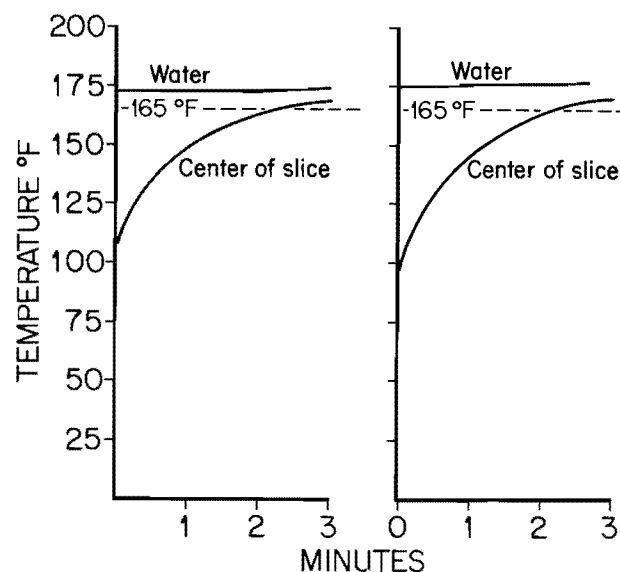


Figure 18. Temperatures of geometric center of slice of gyro meat during reheating in hot water on a range (two trials, Operation 4).

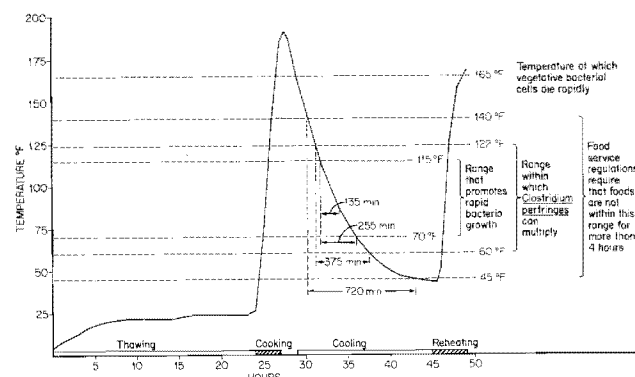


Figure 19. Time-temperature curve for geometric center of gyro during cooking, cooling, and reheating (Operation 2).

(Operation 4; Table 4), is compatible with this hypothesis.

Reheating slices of meat in a microwave oven, on grilles, and in either hot water or broth, for a sufficiently long time, caused the interiors to reach temperatures that would be lethal for vegetative pathogenic foodborne bacteria, but which would not destroy staphyloenterotoxin.

TABLE 4. Isolation of certain foodborne pathogens from gyros in three foodservice establishments.

Operation	Organisms	Treatment/Location of sample			
		Raw/surface	Cooked/just under surface	Cooked, cooled, and reheated/just under surface	Cooked, cooled, and reheated for second time/center
2	<i>C. perfringens</i>	10	10	*	
	<i>S. aureus</i> (MPN)	3	3		
	<i>Salmonella</i>	Neg	Neg		
3	<i>C. perfringens</i>	10	10		
	<i>S. aureus</i> (MPN)	430	3		
	<i>Salmonella</i>	Neg	Neg		
4	<i>C. perfringens</i>	10	10	10,000	1,000
	<i>S. aureus</i> (MPN)	230	3	230	2,400
		750	3		
	<i>Salmonella</i>	Neg	Neg		
		Neg	Neg		

*Blank spaces indicate that no samples were taken.

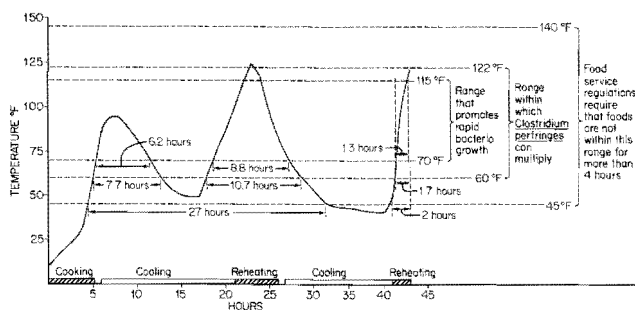


Figure 20. Time-temperature curve for geometric center for gyro during cooking, repeated cooling and reheating (Operation 4).

RECOMMENDATIONS

Cooking

Gyros should be as small as practicable to meet anticipated serving needs. It is better to cook several small gyros throughout the day rather than one large gyro. The outside surfaces of gyros should be thoroughly cooked before carving.

Slicing

Knives and carved-meat catching pans should be cleaned and disinfected before use and after cuts are made that are deep enough to penetrate or slice into raw or undercooked regions of a gyro.

Hot holding

Whenever meat is sliced from the gyro and held warm until served, internal temperatures at the center of the stack of slices or cuts of meat should stay above 54.4 C (130 F), preferably at or above 60 C (140 F).

Cooling

It is best not to keep leftover gyros overnight. If they are kept, however, they should be either small in diameter or reduced in size. Never leave the gyros on the broiler overnight.

Leftover gyros that are 10 cm (4 inches) or less in diameter can be cooled by leaving them on the spit and putting them into a walk-in refrigerator that maintains temperatures below 4.4 C (40 F).

Leftover gyros that are larger than 10 cm (4 inches) in diameter should be trimmed to that size, and the trimmed cuts of meat should also be 10 cm (4 inches) or less in any dimension. The gyro should be stored as above. Alternatively, the spit should be pulled out and the gyro sliced or cut into sections not more than 10 cm (4 inches) in any dimension. The cuts should be put either into pans to form a single layer only or wrapped in foil or plastic and put on a shelf in a single layer with air space around them. (These procedures are only practicable if there are satisfactory reheating arrange-

ments for the slices or cuts.)

If practicable, rapidly cool the gyro or portions cut from it by ice or water baths, cold plates or pans or blasts of cold air as recommended by Bryan and McKinley (3,4) before putting them in the refrigerator.

Reheating

Gyros of 10 cm (4 inches) or less in diameter can be reheated once on the open broiler, but any leftovers from this second heating should be discarded. Take particular care (even more so than during cooking) that the outside surfaces and other regions to be cut off are thoroughly cooked before carving.

Reheat chilled, leftover cuts of gyro meat to an internal temperature of 71.1 C (160 F) or higher. A cleaned and disinfected thermometer should be inserted so that the sensing portion is in the geometric center of the cut of meat or the stack of slices, so that the operator can see if a temperature of at least 71.1 C (160 F) is reached before the meat is served.

Sandwich-size portions of sliced gyro meat should be reheated to 73.8 C (165 F) or higher. These temperatures can be obtained by heating the meat on grilles, in boiling water or broth, in microwave ovens, in pressure cookers or in other steam-heated chambers, if enough time is provided.

ACKNOWLEDGMENTS

Thanks are given to Dr. Eldert Hartwig, Louise Glymph, Norma Mayor, and Frank Reeves, Florida Department of Health and Rehabilitative Services, Tampa Branch Laboratory, Tampa, Florida, for their assistance in analyzing the samples.

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