TIME-TEMPERATURE RELATIONSHIPS OF BEEF PATTIES MADE WITH WHOLE EGG SOLIDS[1]

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Whole egg solids are now manufactured in quantities so large that this item has been on the list of surplus foods. The use of these eggs in food production is somewhat limited because it is recommended *(4, 10)* that whole egg solids be used only in "thoroughly-cooked" menu items because of salmonellae which might possibly be present in the egg *(2, 11)*. Dack *(5)* has indicated that no methods have yet been developed that would guarantee frozen or dried egg products completely free of salmonellae.

It must be expected that the heat treatment necessary to kill salmonellae is affected by, among other factors, the nature of the substrate in which the bacteria are suspended while being subjected to heating. Several researchers have studied the thermal death times on staphylococci and salmonellae when submitted to varying heat treatments in foods that are somewhat similar in type to beef patties. Wiedeman *et al. (12)* injected staphylococci and salmonella organisms into meat loaves. When the loaves were cooked to an internal temperature of 160°F, the number of bacteria was reduced from about 10 million to less than 100 per g of the raw meat loaf medium. Castellani *et al (3)* studied the temperature required to kill salmonellae and other bacteria in the interior portion of stuffed turkeys and several factors affecting the attainment of this temperature. From their observation the authors concluded that the roasting process should not be interrupted until a temperature of 165°F is reached in the center of the stuffing. Hussemann and Buyske *(6)* investigated the time-temperature relationships of *Salmonella typhimurium* in chicken muscle and concluded that the organism appeared to survive a higher temperature in chicken muscle than when broth was used as the menstruum. The salmonellae were reported to survive a 5-min exposure to 194°F, and were destroyed after a 10-min exposure to that temperature.

Angelotti *et al. (1)* determined the thermal death times for salmonellae and staphylococci in certain proteinaceous foods as custard, ham salad, and chicken a la king. The foods were subjected to temperatures of 130°F through 150°F. The authors concluded that heating foods of this nature to 150°F and holding the food "at this temperature for at least 12 min reduced 10 million or fewer salmonellae or staphylococci per g to levels which were not detectable. The same degree of destruction was achieved in similarly contaminated foods held at 140°F for 78 to 83 min."

To make survival studies on salmonellae meaningful, information is needed on the extent of heating received by menu items containing dried eggs when cooked, under varying conditions, to a stage of doneness acceptable for service. Such time-temperature studies have been carried out in this laboratory using souffles and scrambled eggs as well as beef loaf, salmon loaf, and turkey loaf made with whole egg solids as a binder *(7-9)*.

The present investigation is concerned with the time-temperature relationships determined in baked meat patties made using whole egg solids as a binder. The patties were heated to varying internal temperatures and then judged for doneness.

EXPERIMENTAL PROCEDURE

The variables were the fat content[3] of the ground beef (23%, 29%, and 36%), and the endpoint of baking (145°, 160°, and 175°F). From each kind of beef patties were made and baked to the different endpoints. Two replications were carried out. An analysis of variance was carried out on the total times the loaves remained at and above 141°F and on the total weight loss.

The meat patties were prepared in a 12-qt mixing bowl from 2700 g of ground beef, 66 g of finely ground dry bread crumbs, 138 g of an egg preparation made from one part whole egg solids and three parts of water by weight, 12 g of granulated onion (Gentry) and 38 g of salt. After blending for two min at No. 1 speed (Hobart, Model A-200), 113.2-g portions were weighed, shaped into patties 4 in. in diameter and 1.5 cm in depth, and placed in an ungreased aluminum baking pan (25 x 16½ x 1 in). All ingredients were at 50°F. The patties were baked

[1]This is part of a larger project titled "Quality of Selected Menu Items Prepared in Quantity with Whole Egg Solids."

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[3]The samples were analysed for fat content according to the official method of analysis of the Association of Official Agricultural Chemists (1960), section 23.005a.

TABLE 1. TIMES DURING WHICH 4-OZ MEAT PATTIES, MADE WITH WHOLE EGG SOLIDS, AND BAKED TO THREE INTERNAL TEMPERATURES, REMAINED WITHIN CERTAIN TEMPERATURE RANGES; TOTAL BAKING TIMES, TOTAL WEIGHT LOSSES, AND JUDGMENTS.

Fat content of meat	Av. oven temp.	End-point of baking	Time patties remained at[a]					Total[a] baking time	Total[a] weight loss	Acceptable for[b] quantity service			Doneness rating[b]				
			140°F & below	141°F - endpt.	151°F - endpt.	161°F - endpt.	171°F - endpt.			Size	Moist-ness	Done-ness	Rare	Med. rare	Med-ium	Med. well	Well
(%)	(°F)	(°F)	(min)	(min)	(min)	(min)	(min)	(min)	(g)	(No)	(No)	(No)	(No)	(No)	(No)	(No)	(No)
23	326	145	9.6	1.3				10.9	196.3	24	24	24		13	42	45	44
	325	160	11.8	4.7	3.1			16.4	277.2	24	24	24			2	55	87
	325	175	11.0	7.5	5.7	4.1	1.4	18.5	408.0	24	24	24			9	53	82
29	328	145	9.8	1.0				10.8	481.2	24	23	20	10	42	17	35	40
	326	160	9.8	3.5	2.1			13.3	651.6	24	20	21		2	21	23	98
	325	175	11.2	6.4	4.8	3.4	1.7	17.6	724.8	24	21	22			1	18	125
36	321	145	10.5	1.1				11.6	677.1	24	24	24		1	75	26	42
	328	160	9.2	3.1	2.7			12.3	721.8	24	23	24			21	84	39
	314	175	11.5	7.3	5.5	3.5	1.4	18.7	967.0	24	24	24				7	137

[a]Mean values of 2 replications.

[b]Acceptability: a total of 24 judgments (2 representative patties were evaluated for acceptability by 6 judges). Doneness Ratings; a total of 144 judgments (all 24 patties were rated for doneness by 3 judges).

in the middle deck of a Hotpoint[4] electric oven. The average oven temperature was 325°F, the temperature varied within a 35°F range.

Throughout the investigation temperature determinations were made on the patties and in the oven by means of copper-constantan, ceramic-insulated thermocouples and an electronic potentiometer[5]. In the oven, two thermocouples were located approximately 3 in from the side walls, and midway the front and rear of the oven. In the patties, the thermocouples were located in the horizontal and vertical center of the pattie. Baking was ended when the specified final temperatures were reached in two representative patties located in the coolest area on the baking sheet. Preliminary tests were carried out to determine which of the 24 patties would be located in the coolest areas. To do this, slices of white bread were placed on the pan and baked at 350°F for 25 min. From color observations made on the slices, the coolest areas on the pan were determined.

After baking, the patties were placed on a wire rack and allowed to cool for 5 min. Weight losses were determined for the two representative patties and also for the 22 remaining patties. The total volume of drippings were obtained from the patties made from the ground beef containing 29% and 36% fat. The drippings were collected in a 500-ml graduate cylinder, 5 min after the patties were removed from the oven.

Subjective observations were made on the two representative patties within 8 min of weighing the patties after baking. Six judges, all members of the Institution Management staff, were asked to judge the two representative patties for acceptance for quantity food service, regarding size, moistness, and doneness. In addition, the degree of doneness for all 24 patties was determined by three judges who were asked to slice the 24 patties and to place them in one of five categories: rare, medium rare, medium, medium well, and well done.

RESULTS

The data representing the times during which the 4-oz meat patties remained within certain temperature ranges, total baking times, total weight losses, and judgments are given in Table 1.

The final internal temperature to which the patties were baked was a significant variable influencing the length of time during which the patties remained at and above 141°F. The effect was linear in that as the final internal temperature increased the time increased proportionately. The variable was signifi-

[4]Model HK 50.

[5]Minneapolis Honeywell, Model 153 x 64P 12-x-41.

TABLE 2. VOLUME OF FAT AND NON-FAT DRIPPINGS COLLECTED FROM THE PATTIES BAKED FROM GROUND BEEF[a] CONTAINING 29 AND 36% FAT.

Fat content of meat	Endpoint of baking	Volume of drippings		
		Fat	Non-fat	Total
(%)	(°F)	(ml)	(ml)	(ml)
29	145	160	124	284
	160	162	217.5	379.5
	175	250.5	200.5	451
36	145	285	190	475
	160	347.5	205	552.5
	175	397.5	255	652.5

[a]Mean values are presented.

cant at the 1% level. The percent of fat in the meat did not significantly influence the time the patties remained at and above 141°F.

Variables that significantly influenced the total weight loss of the patties were the percent of fat in the meat and the final internal temperature of baking. The influence of the fat content was significant at the 1% level. The influence of the internal baking temperature was also significant at the 1% level; as the final internal temperature increased the loss in weight increased linearly.

The total volume of drippings collected from the patties made from beef samples containing 29 and 36% fat are presented in Table 2. As the fat content of the meat was increased from 29 to 36%, the total volume of drippings increased by 50.6%. In general, the total volume of drippings also increased as the final internal temperature increased. The average increase was 85 ml as the final internal temperature was increased from 145° to 175°F.

DISCUSSION

It is difficult to evaluate the bacteriological safety of the beef patties at this time because no results of survival studies are available in the literature that would make definite conclusions possible. However, a word of warning is in order. Even the patties heated to an internal temperature of 145°F were considered acceptable in doneness by the judges; this indicates that in these patties doneness was not a reliable criterion for bacteriological safety.

The patties heated to an internal temperature of 175°F were considered acceptable for service regarding size and moistness, in spite of the relatively high cooking losses.

Attention is called to the fact that in the present study a medium-low oven temperature was used and that cooking times might be somewhat shorter if higher temperatures were used.

The data presented here cannot be completely evaluated until more time-temperature data have been derived with salmonellae as test organisms suspended in menstruums similar to those used here and under rather short holding times at temperatures above 150°F.

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