FACTORS AFFECTING THE QUALITY OF ROASTED TURKEY

by

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INTRODUCTION

Turkey production has increased tremendously during the past 30 years. In 1920 the turkey population was 3,000,000 and in 1952, 60,000,000. The trends toward specialization and operation with improved methods of distributions have increased the farm yard flock of birds to sizes that range from 1,500 to 10,000 (Turkey Handbook as published by the National Turkey Federation; ca. 1954c; this publication elsewhere is referred to as Turkey Handbook, ca. 1954c). Improved methods of picking, eviscerating, packaging, and cold storage with year round distribution of improved products have turned the holiday luxury bird into an everyday source of economical and healthful food. Larson (1956) reported that during the years 1930 to 1950, there was an increase in frozen turkey storage from 10,000,000 to 127,000,000 pounds.

Iowa has kept abreast with the growing popularity of the bird and now ranks third in the nation in the production of the heavy breeds exceeded only by California and Minnesota. In total turkey production, however, Iowa, surpassed by Virginia, is in fourth place (Wood, 1957).

The demand for turkeys for household and institution use has increased with production. The present meaty, tender, plump, and compact bird is now two-thirds light meat and one-third dark. In 1950 the American public used 20 percent more

turkey than it did in 1949. Data, from a survey conducted in 46 states of 207 restaurants serving a total of 124,000,000 meals annually, revealed that turkey was the only poultry served in four of the institutions and that 81 or 37 percent of these served more turkey than any other poultry. Of the total 541,000 commercial eating establishments in 1952, reports from a survey of 218 restaurants in 46 states and the District of Columbia showed that 86 percent served turkey dishes, 76 percent reported an increase in service throughout the year, 65 percent served more turkey than they did five years ago, and 79 percent served more than they did 10 years ago (Turkey Handbook, ca. 1954c). Joule (1957) reported that although turkey was still less than 2 percent by weight of the meat we eat, the per capita consumption of turkey had increased faster than that of any other meat.

Commercially frozen turkey rolls, now merchandized in 33 states, have been winning consumer confidence, approval, and acceptance. The present outlet for these rolls has been largely through hospitals, schools, dining cars, cafeterias, restaurants, and caterers.

Some of the more pertinent problems in the preparation and service of turkey in quantity are:

1. Length of time required and difficulties encountered in roasting whole birds to optimum palatability of light and

dark meat.

2. Space necessary for storage and roasting of whole birds.

3. Availability and expense of skilled workers to carve cooked birds into standard portions.

The increased use of turkeys in institutions has accentuated the problems. With whole turkeys taking up proportionately more space than previously, the possibility of removing the bones to reduce space necessary for refrigeration and cooking have been considered. If turkey rolls were to be used, research was needed:

1. To compare the length of time for cooking whole turkeys versus that for cooking turkey rolls.

2. To determine desirable final internal temperatures for cooking light and dark meat turkey rolls.

3. To investigate the effect of removing the bones upon the quality of turkey.

4. To determine an acceptable oven temperature for roasting turkey rolls for maximum quality and yield.

With these problems in mind the objectives of the present investigation were:

1. To investigate the relation of three oven temperatures and two internal temperatures of cooked light meat and dark meat turkey rolls with regard to quality and yield of cooked edible meat.

2. To determine the difference between roasted whole turkey and turkey rolls with respect to quality, yield, and portion control.

3. To investigate the cooking time required for whole turkey and for turkey rolls to reach certain specified internal temperatures.

Frozen, oven-ready, Grade A tom turkeys, 20 to 22 pounds, and six months of age were obtained. The 69 Broad Breasted Bronze turkeys used for preliminary and actual experimentation were from the same flock, and had received similar ration. Thus, age, feed, breed, and processing were uniform for the turkeys used in this study. Turkeys were thawed at 39 ± 1°F. for approximately 72 hours in a walk-in refrigerator. One light meat roll was prepared from the whole breast of one turkey while the dark meat roll was prepared from the thigh and adjoining back muscles.

In the first part of the experiment, the design was such that turkeys were deboned, rolled, and dry roasted to two internal temperatures for light meat rolls and two for dark meat rolls at three oven temperatures. In the second part of the experiment, whole birds, light meat, and dark meat rolls were roasted at one oven temperature.

Rolls were machine sliced, and samples were served to a panel that scored the products for the quality factors:

aroma, flavor, tenderness, juiciness, and degree of doneness. Shear force measurements were made on cooked samples of light meat rolls.

The experiment was designed so that the statistical significance of results could be tested for initial and final weights, cooking time, cooking yields, losses, and quality factors. Data were obtained to determine the correlation between the objective measurements for shear force and the judges' scores for tenderness.

REVIEW OF LITERATURE

A survey of the literature reveals only a limited amount of data on the many factors influencing the quality of roasted turkey. Because of the lack of uniformity in procedures and practices, it is difficult to compare findings. Many of the recommendations have been based on general observations as presented in cook books and not on scientifically controlled experiments. The literature reviewed here is directly related to the objectives and procedures of this study.

Composition of Turkey Meat

A number of investigations have been made to determine the composition of turkey meat. The authors have differed slightly in their findings and in their methods of presenting the data. In Table 1, data have been summarized as they apply to raw or cooked whole turkey, light and dark meat.

According to Babcock (1950), a 100 gram portion, 3 1/2 ounces, of raw edible turkey will supply the following percent of the total recommended allowance for a physically active man:

Energy	9	Vitamin A	(0)
Protein	28.5	Thiamine	6
Fat	20	Riboflavin	8
Calcium	2.5	Niacin	53.5
Iron	31.5	Ascorbic acid	(0)
Phosphorous	21.3	Carbohydrate	0

Table 1. Composition of turkey

Nutrient	Whole turkey		Light meat		Dark meat		Reference[1]
	Raw	Cooked	Raw	Cooked	Raw	Cooked	
Protein	---	---	24.5	---	23.2	---	A
%	20.1	27.0	---	---	---	---	C
	21.1	26.6	---	---	---	---	D
	21.1	26.6		33.5		30.8	E
				35		30	F
Fat			4.6		9.4		A
%	20.2	18.0					C
	13.6	14.0					D
	13.6	14.0		6.7		11.2	E
				8.3		11.2	F
Moisture							
%	58.3	54.0	---	---	---	---	C
	64.4	58.2	---	---	---	---	D
	64.4	58.2	---	59		57	E
Ash	1.0	1.1					C
%	1.05	1.04					
	1.05	1.04		1.1		1.0	E
Food energy /100 g.	268						C
	207	232					D
	207	232		194		224	E
Niacin mg/100 g.	.4 to .7 .8		.10 to .15		.4 to .7		B
				.94		4.1	E
Thiamine mg/100g.	.09		.07	0.42	.09	0.94	B C
Riboflavin mg/100g.	.14		.15		.10		B C

[1] Authors referred to are:
A - Chatfield and Adams (1940)
B - Cook et al. (1949)
C - Watt and Merrill (1950)
D - Turkey Handbook (ca. 1954c)
E - Scott (1958)
F - Huddleson (1957)

Among four varieties and strains of turkeys, Broad Breasted Bronze, Standardbred Bronze, White Holland, and Beltsville Small White, the content of fat in the breast and leg muscles varied little. In other parts of the carcass and total edible portions, fat content was highest in Beltsville Small White, lowest in Broad Breasted Bronze and intermediate in Holland and Standardbred Bronze. Females in all strains showed a higher fat content than males in the other parts of the carcass and total edible portions. Protein, ash, and water content varied inversely with the fat content. According to the statistical analyses, among varieties and strains of turkeys there were differences in the rate of fattening at which birds obtained a desirable finish. This finding was considered important in determining the market age of turkeys (Marshaw et al., 1943).

In an investigation by Lewis, Harrison and Folse (1958) in which the quantity and distribution of fat were determined, it was shown that certain sections from the pectoralis major muscle contained a medium quantity of fat and other sections little or none. In the pectoralis major, the fat occurred usually in one or two clusters in some sections of muscle tending to push the muscle fibers to one side. In the gluteus primus muscle, there were large and small groups of fat cells well distributed throughout an entire section; the cells were lined in narrow rows between the muscle fibers with several

rows in each section. Although the area of fat was 14 percent larger in the gluteus primus muscle there was no significant difference in the fat in sections from the gluteus primus or pectoralis major.

Fatty acid composition and oxidation deterioration of turkey fat during intervals of storage at 0°F. were investigated by Privett et al. (1955). Surface fat appeared oxidized and became rancid. The linoleic and linolenic acids in the turkey fat seemed more susceptible to oxidation than many other fatty acids.

In an investigation of vitamin losses, Cook et al. (1949) found no significant loss of vitamins during three to nine month's storage at -23°C., except for thiamine in breast and leg muscles of one lot of turkeys. However, loss of thiamine in cooking was high: 67 to 82 percent in leg and skin and 38 to 43 percent in breast meat. Losses for riboflavin and niacin were 20 to 30 percent.

Turkey Rolls and Cut Up Turkey

Katzenstein (1956) defined turkey logs or rolls as "raw frozen skin and meat of turkey either molded in cylindrical or rectangular shape or tied in a roll." He suggested that the skin weight should be 8 to 14 percent of the total log weight with 55 percent light meat and not more than 45 percent

dark meat. Neck meat, tail, fat, giblets, other organs, and glands were usually excluded. When string was used at two or three inch intervals for tying, no molds were used. According to Hodgson (1949), logs were designed primarily to meet institution needs; they were wrapped in a moisture and vapor retaining foil and cooked in the same package. Rolls have been processed in various ways, for example Forward and Joule (1955) reported that the University of Missouri has prepared several types of turkey rolls: fresh, fresh cooked, fresh cooked with dressing, dry sugar cured, smoked and dry sugar cured, smoked cooked, wood smoked, breast rolls, and sandwich loaf or rolls.

Several investigators have reported on the advantages of turkey rolls which make it possible to have the advantage of the rich flavor and tender succulent meat of turkey without the bulk of the whole bird. The National Turkey Federation, Turkey Handbook (ca. 1954c) reported that when cut up turkey or rolls were cooked, there were increased yields of cooked meat, decreased need for storage and oven space, and a reduction in the total time for cooking. Then, too, rolls or other boneless pieces could be sliced mechanically for minimum waste, reduced labor cost, and better portion control.

Evans and Associates (1956) reported that the cooking time for cut up parts was only one-half that of whole turkey.

He suggested wrapping sliceable meat in foil or wax paper and chilling or "firming up" in the refrigerator for easier slicing.

From the standpoint of labor and yield, Richey (1957) considered it was most desirable to use heavy toms, 24 pounds and up ready-to-cook weight, to prepare turkey rolls. He stated that birds should be chilled down to a temperature of 40°F. before boning. In general, pressure packed commercially prepared rolls are 60 percent light meat and 40 percent dark meat and in some cases seasoning is added. At the Ellsworth, Iowa processing plant, nine pound rolls, 15 inches long and 4 1/2 inches in diameter, are blast frozen in molds; then unmolded and wrapped in foil.

Joule (1957) advocated the use of turkey rolls in preference to whole bird to reduce storage space, labor, cooking and serving wastes, serving time, and transportation costs. Rolls were more convenient to store, handle, and use. They were more versatile for preparing turkey meat dishes and more adaptable to any season.

Roasting of Turkey

Various factors affecting the roasting of turkey are (a) weight of the bird, (b) shape of the bird, (c) fat deposition, (d) composition of the meat, (e) initial temperature

of the bird, (f) cooking temperature, (g) methods of preparation and cooking and, (h) degree of doneness.

The reports of investigations of minutes per pound cooking for dry roasting turkey are summarized in Table 2.

Table 2. Cooking time for dry roasted turkey

Turkey	Weight	Oven temperature	End point	Place	Cooking time	Reference[1]
	lbs.	°F.	°F.		min/lb.	
Whole	17.10	400	190	thigh	7.72	A
	17.12	300	185	thigh	11.3	A
	19	282	194	thigh	18.4	C
Halves	14 to 16 whole	325	185	breast	20.7	B
		325	194	breast	25	B
		325	185	thigh	19	B
		325	194	thigh	20.4	B
	19	300	203	thigh	23	D
	19	300	194	thigh	18	D
Light meat roll	7.0	300	185	center	31.6	E
Dark meat roll	4.2	300	194	center	42.6	E

[1]Authors referred to are:
A - Edgar (1953)
B - Cooley (1956)
C - Crowe (1957)
D - Ferguson (1957)
E - Brisbane (1958)

The cooking time in minutes per pound varied with the methods of preparation and cooking. In a study conducted by Edgar (1953) to determine the effect of two oven temperatures and aluminum foil on cooking time, whole turkeys were

roasted at oven temperatures of 300 and 400°F. At an oven temperature of 300°F., birds wrapped in foil were roasted to an interior thigh temperature of 180°F., without foil, to 185°F. Minutes per pound were 18.25 and 11.3 respectively. When an oven temperature of 400°F. was used, birds wrapped in foil were roasted to 185°F., without foil to 190°F. Cooking time in minutes per pound was 12.23 and 7.72 respectively. Temperature of the oven and the use of foil were found to affect the rate of heat penetration. After the initial period during which heat penetrated the muscle, there was rapid rise in the internal temperature. The rate of rise in the internal temperature was more rapid at the higher oven temperature and the total cooking time was shorter. If turkeys were cooked at an oven temperature where the rate of heat penetration was rapid and the total cooking time was short, then the turkey needed to be cooked to a higher internal temperature (approximately 6°F.) to reach the same degree of doneness. She stated that in order to evaluate the birds, it seemed better to have the meat cooked to the same degree of doneness than to have the final temperature the same.

According to Cooley (1956), when turkey halves were roasted at an oven temperature of 325°F., the average rise in temperature in the thigh and breast muscles was steady but the rise was more rapid in the thigh than in the breast. The lag after about 80 minutes was more pronounced in the pectoralis

major than in the thigh, and indicated that coagulation began earlier in the breast muscles.

Iacono et al. (1956) reported in detail the heat penetration in 11.4 pounds thawed turkeys and 13.7 pounds frozen turkeys in Table 3.

Table 3. Heat penetration data[1]

Thermocouple No.	Points in which thermocouples were placed in tissue	Depth of thermocouple in tissue	Time required to raise temperature to 65°F.	Time required to raise temperature to 185°F.
		Inches	Minutes	Minutes
	Thawed roast			
I	Right breast	2	30	240
II	Left thigh	2½	30	216
IV	Right drumstick	2¼	30	207
V	Left rear breast	2½	36	197
VI	Posterior part of entrail cavity	2	120	249
	Frozen roast			
VII	Right breast	1	47	300
VIII	Left thigh	1½	120	378
IX	Right drumstick	1	81	315
X	Left rear breast	1¼	90	316
XI	Posterior part of entrail cavity	½	90	---

[1]According to Iacono et al., p. 12, adapted

Crowe (1957) roasted whole birds at an oven temperature of 275 ± 5°F. to 194°F. in the thigh muscles. She reported that the most rapid increase of internal temperature occurred during the first three hours. When the breast meat reached

approximately 137°F. and the thigh meat 158°F., the rate decreased. There was a lag in the fourth hour and an increase in rate the fifth hour. In general, when the end point 194°F. was reached in the thigh, the temperature in the breast averaged 183°F.

Ferguson (1957) studied the relationship between degree of doneness and end point temperatures of roasted turkey halves. For birds cooked at an oven temperature of 325°F., there was a rapid and similar rate of increase in temperature in breast meat for the first hour. In thigh meat the rise was slow during the first 20 minutes with a rapid progression until the rate of heat penetration became similar for both breast and thigh muscles. Coagulation began after a shorter time interval in the breast than in the thigh. After the beginning of protein coagulation, the rate of heat penetration became progressively slower until the predetermined end point had been reached.

Brisbane (1958) compared two methods of preparing turkey rolls, dry roasting, and poach roasting. Light meat rolls contained breast and wing meat from the first joint; dark meat rolls contained leg, thigh, and back meat. She reported that increase in temperature was faster in the poach roasted rolls the first three hours than in the dry roasted rolls. For the rest of the cooking time, the rise was more nearly alike and

the poach and dry roasted rolls reached the predetermined end points approximately the same time. Thermocouples placed at the ends of the rolls recorded a faster increase in temperature than did thermocouples in the center until a plateau had been reached.

Yields of Cooked Meats

Many reports on yield are difficult to interpret because of a lack of agreement in methods used, standardization of procedure in reporting results, and confusion in terms used such as: pan-ready, oven-ready, oven-dressed, and ready-to-cook. Unless otherwise indicated, the reports reviewed are primarily for yields related to heavy toms, 20 to 22 pounds in weight. However, yield data that seemed comparable have been summarized in Table 4.

Experiments were conducted in the University of Nevada Agricultural Experiment Station to determine the relation of size of turkeys to economy of production, edible meat in carcass, and weights of parts of carcass (Headley, 1948). This study in which 150 each of medium Broad Breasted Bronze and Beltsville Small Whites were used, showed that the percent yield of edible meat was closely related to the dressed weight regardless of the sex or variety. Size and individuality of the birds are the basic determining factors in the amount and percentage of meat. Formulas were developed to determine the percentage yields for dressed or drawn turkeys. The weight

Table 4. Yields from dry roasted turkey

Whole	Weight		Edible meat			Skin and bones	Light meat		Dark meat		Reference[1]
	Raw	Cooked									
	lbs.	lbs.	%	lbs.	%	%	lbs.	%	lbs.	%	
Live	24.2	13.4	--	10.4	--	--	4.0	--	--	--	A
N. Y. dressed	20	--	83	--	57.5	41	--	59.3	--	41	B
	25	--	75.2	--	80	19.1	--	63	--	36	B
Drawn	20	--	60	12	43	--	--	--	--	--	B
	22	--	60	13	52	--	--	--	--	--	B
	19	17	55	10	40	--	--	--	--	--	B
	17	--	--	10	50	--	--	--	--	--	B
Eviscerated	20	--	68.3	--	60.6	39.4	--	61.8	--	38.2	B
	20	--	65.5	--	66.5	33.5	--	58.8	--	41.2	B
	18-20	--	--	8	--	--	--	--	--	--	B
	17.4 to 19.2	--	--	9.75	--	--	--	--	--	--	B
	25	--	--	9	--	--	4.2	--	3.6	--	B
Ready-to-cook	22.6	--	--	--	56.7	--	--	67.7	--	53.5	C

[1]Authors referred to are:
A - Cline (1947)
B - Turkey Handbook (ca. 1954c)
C - Winter and Clements (1957)

of any part may be estimated by using the appropriate constant given (Table 5).

Table 5. Equations for calculating turkey parts from dressed and drawn weights[1]

To estimate	Given dressed weight: Multiply given wt. by	Subtract	Add	Given drawn weight: Multiply given wt. by	Subtract	Add
Live weight	1.07	.00	1.06			
Drawn weight	.83	.00	.21			
Roasted weight	.67	.64	.00			
Edible meat	.56	.47	.00	.66	.56	.00
Breast meat	.234	.69	.00	.28	.73	.00
Legs, entire	.166	.10	.00	.20	.13	.00
Leg meat	.125	.04	.00	.15	.06	.00
Wings, entire	.076	.00	.12	.058	.00	.00
Wing meat	.061	.08	.00	.09	.00	.00
Giblets, uncooked	.024	.00	.24			
Back meat	.122	.24	.00	.148	.28	.00
Skeleton	.147	.00	.00			

[1]According to Headley (1948, p. 12), adapted

According to Hawks (1954), there may be a difference in yield of birds due to form and structure. He reported that heavy fat broad breasted birds did not yield as much meat as did long keeled fleshy birds.

At the University of Minnesota, it was determined that if the turkeys were the same age the body weight was the most useful measure of meat yield with body depth the next. Breast widths, keels, and shank lengths were of little, if any, value

in predicting yields (Berg, 1955).

In the selection of birds for meat yields, Kondra and Schoeffner (1955) supported the theory that body weight and breast width should not be over emphasized at the expense of reproductive traits such as egg production, fertility, and hatchability. All of these factors are important in the economy of turkey production.

Differences in breed were considered as determining factors in the yield of edible meat of turkeys by Orr et al. (1956). On the basis of live weight, Broad Breasted Bronze turkeys had a significantly higher weight than any of the other five breeds examined. Males gave a significantly higher yield than females in mature birds but not at the broiler age. On the basis of the ready-to-cook weight, Beltsville Small Whites at the broiler age had weights which were significantly higher than any of the other breeds tested.

Longer cooking at lower temperature is recommended for greater yields. National Turkey Federation, Turkey Handbook (ca. 1954c) reported 30 more 2 ounce portions from a 25 pound turkey roasted at 325°F. for 4 1/2 to 5 hours than from the same weight bird roasted at 450°F. for 3 hours.

For the ready-to-cook turkey without giblets and neck, Pecot and Watt (1956) reported percent yields for birds 12 pounds or over as indicated in Table 6.

Table 6. Percent yields from eviscerated turkeys

	Average	Range
Roasted, bone in	72	56-82
Cooked meat, including skin	71	57-88
Cooked meat, excluding skin	59	48-77
Parts, roasted bone in		
Breast, including skin	89	86-92
Drumstick, including skin	69	63-73
Thigh, including skin	81	76-84
Wing, including skin	63	55-69
Steamed, bone in		
Cooked meat, excluding skin	57	48-62
Boiled, bone in		
Cooked meat, excluding skin	62	56-70

Schlosser et al. (1957), compared the yields and losses of steamed and braised turkeys. The yield of turkey steamed at 5 pounds pressure was 43 percent, at 15 pounds pressure, 44 percent, and braised at an oven temperature of 325°F., 45 percent. These percents were based on ready-to-cook weights.

In a study by Crowe (1957), the average percentage yield of dry roasted turkey for total edible meat was 39; for sliced light meat, 23; sliced dark meat, 12 and edible trim, 4. The dry roast method gave a 2 percent greater yield of edible meat than the birds roasted covered and uncovered or steamed and roasted in her study. The above percents were based on the weights of ready-to-cook turkeys. These ready-to-cook turkeys were frozen oven dressed birds which were thawed and washed; excess moisture, neck, giblets, and fat were removed. Elsewhere in this review of literature, the term ready-to-cook

refers to eviscerated vacuum packed frozen birds.

Dawson et al. (1958) compared yields of cooked edible turkey on the basis of the as purchased weights. Broad Breasted Bronze ready-to-cook turkeys, 22 pounds without neck and giblets, roasted for 5 hours at 325°F. yielded 46 percent edible meat without skin. The yield was approximately the same when roasted at oven temperatures of 300 to 325°F. as when steamed. The range in percent of cooked edible meat was from 38 to 42, whereas, on the basis of the New York dressed weight, the range was from 31 to 33 percent. The yield was about the same for light weight, medium, and heavy toms. Large Broad Breasted Bronze ready-to-cook turkeys simmered with neck and giblets yielded 47 percent cooked edible meat and skin.

When comparisons of yields were made for turkey cooked by different methods, Batey (1954) reported that poach roasting turkey increased the yields to 63.7 percent usable meat. The following yields were given for two whole turkeys dry roasted and one turkey cut into parts and poach roasted. In 1955, Batey compared roasted whole birds and poach roasted rolls cooked at an oven temperature of 325°F. Whole birds gave a 42 percent yield while the rolls which cooked in half the time yielded 63.7 percent cooked usable meat. (Table 7).

The National Turkey Federation, Turkey Handbook (ca. 1954c) reported up to 60 percent yield in cooked edible boneless meat

Table 7. Yields from dry roasted and poach roasted turkeys

	Whole turkeys dry roasted		Turkey parts poach roasted
	I	II	
Eviscerated weight, A. P.	401 oz.	402 oz.	408 oz.
Thawed weight	388 oz.	394 oz.	402 oz.
Cooking time	6½ hrs.	5½ hrs.	2 3/4 hrs.
Oven temperature	275°F.	325°F.	325°F.
Cooking shrinkage from A. P. weight	200 oz.	233 oz.	148 oz.
Cooked weight yield, in percent of A. P. weight	50.1	42.0	63.7
Usable meat total	201 oz.	169 oz.	260 oz.
Breast	67 oz.	76 oz.	133 oz.

on the basis of the eviscerated weight. The best yield was obtained from turkeys 22 pounds and up. In a further report from the Federation, Turkey Handbook, (ca. 1954c) light and dark meat rolls from a 25 pound ready-to-cook turkey, roasted at a temperature not exceeding 340°F. yielded 28 three to four ounce portions. It was suggested that rolls could be hand or machine sliced warm or cold.

In a comparison of two methods of preparing turkey rolls, Brisbane (1958) reported that light meat rolls, dry roasted, yielded 69.5 percent; poach roasted, 70.6; dark meat rolls, dry roasted, 62.3 percent and poach roasted, 61.7. Percent yields were based on the weight of the ready-to-cook roll.

Cooking Losses

Data reported for cooking losses indicate the effect of size, method of cooking, oven temperature, and end point.

When Edgar (1953) roasted turkeys with and without foil at two oven temperatures, total percent cooking losses were similar for birds cooked at the same oven temperature. Birds cooked without foil at 400°F. had highest percent total losses, 23.6, whereas those without foil at oven temperature 300°F. had the lowest, 18.9.

Cooley (1956) found that the average total and volatile cooking losses were greater for turkey halves roasted at 325°F. to an internal temperature of 194°F. than for those roasted to an internal temperature of 185°F. ($P < .001$). Lowest total cooking losses, 16.4 percent, were reported for birds cooked to an end point of 185°F. in the thigh muscles, and highest, 24.1 percent, for birds cooked to 194°F. in the pectoralis major. The mean total cooking losses were 20 percent for turkeys roasted to 185°F. in the pectoralis major and 19.3 percent for turkeys roasted to 194°F. in the thigh.

Cooking losses varied with the method of cooking in a study by Crowe (1957). When birds were steamed and roasted, greatest total losses of 7 pounds were obtained (drip losses, 5 pounds and volatile losses, 2 pounds). Smallest total losses were 6.4 pounds for birds roasted covered and uncovered; drip losses were 4.1 pounds and volatile losses, 2.2 pounds. For dry roasted birds, total losses were intermediate, 6.9 pounds; drip losses were 4.1 pounds, but volatile losses of 2.8

pounds were the highest of the three methods of cooking.

According to Ferguson (1957), when turkey halves were roasted at 325°F. to two end points in the breast and in the thigh, there was a significant difference in the volatile losses ($P < .01$) and total cooking losses ($P < .001$). Birds roasted to 194°F. in the breast and 203°F. in the thigh had approximately 5 percent greater total cooking losses than those roasted to 185°F. in the breast and 194°F. in the thigh. Dripping losses were similar for all birds regardless of their final internal temperature.

When light meat rolls and dark meat rolls were dry roasted by Brisbane (1958), the following total cooking losses were reported: for light meat, 30.5 percent, dark meat, 37.7 percent. Losses for poach roasted rolls were 38.9 percent for light meat and 43.0 percent for dark meat. The losses for dry roasting were based on the weights of the ready-to-cook rolls; losses for the poach roasted rolls were on the basis of the weights of the rolls plus the water included in cooking.

Subjective Evaluation

In a review of the proceedings at a conference on the sensory methods for measuring differences in food quality, Dawson and Harris (1951) reported that poultry should be scored by judges who are consistent in rating palatability

factors and who can remember degrees of quality over long periods of time. They stated that aroma was more pronounced right after cooking and reflected quality rather than flavor. Furthermore, it was suggested that samples which had been carved according to a standardized procedure, about 1/4 inch thick, should be served at the temperature at which the product is normally served. There should be an interval between presenting the light meat and dark meat samples to the judges.

Aroma, flavor, tenderness, and juiciness

Several factors may affect the quality of roasted turkey; some of these factors will be discussed here. Research has been conducted to investigate the effect of feed on flavor. In a study reported by Cook et al. (1949) they stated that off flavors were detected in turkeys which had been fed rations with 13 and 18 percent fish meal. Rancidity was noticed in samples of turkeys fed tocopherol free diets for several days before slaughter.

In a study conducted by Goertz (1955), it was found that there was a slight but not significant preference for roasted turkey and braised turkey steaks from birds fed a high density ration over those fed a low density ration. Birds fed the high density ration were given high scores for flavor, juiciness, and intramuscular fat.

Marsden et al. (1957a) found a direct relationship among diet, composition, fleshing, fatness, and edible quality of female roasted turkeys. Generally turkeys fed 7.2 to 9.2 percent fish meal in all mash growers were graded fatter than those fed on non-fish control diets. In this group, the fatter the turkeys, the more they were graded down for fishy or off flavors. Undesirable odors were reduced by the addition of 2 percent refined cottonseed oil to mash containing 9.2 percent white fish meal while large additions of corn, wheat, and oats had no affect on the predominant fish odor.

In another study by Marsden et al. (1957b), little difference was found in the flavor for turkeys fed on diets high in corn, oats, wheat, or barley. There was little flavor difference in samples from turkeys fed diets high in corn gluten, soybean, peanut, or cottonseed meals. However, birds fed these edible oil meals were rated slightly inferior in flavor to birds fed grain and control rations. Turkeys fed linseed meal were down graded for flavor, and the addition of oats, cottonseed oil, or alfalfa to the mashes containing linseed meal did not improve the turkey flavor. Generally, for each diet, the fatter or older the turkeys, the more juicy the breasts. Thighs were more tender on the average and less variable in tenderness than breast muscles. Juiciness and tenderness of breast muscles and leg muscles were not noticeably affected by variations in the diets.

Lewis et al. (1958) reported that when Broad Breasted Bronze turkeys were fed a one percent xanthophyll concentration 2 to 12 weeks prior to slaughter to determine the effect on the palatability and stability of fresh and frozen turkeys, there were no significant differences in the juiciness and aroma that could be attributed to the diet. Flavor and tenderness scores showed very small differences although at a few periods during the experiment the differences were statistically significant but not considered of practical importance.

Different processing procedures have shown varying effects on the tenderness of turkeys. According to Klose and Poole (1954), variations in scalding temperatures and chilling methods did not have a significant effect on the tenderness of roasted turkey muscles. Poultry subscalded at 138 to 140°F. received scores for tenderness and shear force measurements in close correspondence. The skin, however, increased in toughness as the scalding temperature increased, but autoclaving, simmering, or covering the bird in the oven reduced the skin toughness.

Spencer et al. (1956) reported that turkeys cooled in ice water were as tender as those cooled in a refrigerator during a 16 hour period. Turkeys frozen without precooling were scored less tender.

Taste panels have been used quite extensively in the investigation of the effects of various methods of cooking and different degrees of doneness on the quality of turkey. In Edgar's (1953) study on the quality of roasted turkey cooked with and without foil at two oven temperatures, pectoralis major muscles from turkeys roasted without foil received higher flavor scores than for those roasted with foil. Freezing and storing the muscle for one week caused a drop in flavor scores, while the thigh showed no flavor variation for different treatments. Turkeys roasted at an oven temperature of 300°F. scored higher for juiciness than those cooked at 400°F. These oven temperatures had no significant effect on the tenderness of any of the muscles scored.

According to Cooley (1956), judges gave the lowest flavor scores to turkeys cooked to 185°F. when the thermometer was placed in the thigh muscles. Flavor and tenderness scores for dark meat ranked higher ($P < .05$) when the temperature in the pectoralis major was used as the end point rather than that in the thigh muscle. Turkeys cooked to 185°F. in either pectoralis major or thigh muscle were juicier ($P < .05$) than those cooked to 194°F. Lowest juiciness scores were found for birds cooked to 194°F. in the pectoralis major.

In a study conducted by Schlosser *et al.* (1957) there was no significant difference in the tenderness, flavor, or

general acceptability between turkeys braised or steamed. Generally, light meat was judged more tender than dark meat regardless of method of cooking. Turkey that was steamed at 5 pounds pressure was significantly less moist than the braised turkey. On the other hand, there was almost no difference in moistness of light meat from turkeys steamed at 15 pounds pressure compared to the braised turkey. Moistness scores for all steamed and braised dark turkey meat were similar.

In a comparison of different methods of cooking, judges in Crowe's study (1957) scored turkey for aroma, flavor, juiciness, and tenderness. Light meat from birds roasted covered and uncovered were scored highest for all characteristics except juiciness, which was highest for dry roasted birds. For the dark meat, birds dry roasted were scored highest for all characteristics. There were no significant differences based on intensity for any of the quality factors among the three methods of preparation.

Ferguson (1957) reported that the flavor of light and dark turkey meat was not changed significantly by cooking to different degrees of doneness. Light and dark meat samples were scored similarly for flavor. Also similar scores were given for tenderness of light and dark meat regardless of their degree of doneness. On the other hand, it was found that the juiciness did not differ in light meat by varying

the end point, but the differences in dark meat were significant since turkeys cooked to 194°F. in the thigh had the highest scores for juiciness, and those cooked to 203°F. in the thigh had the lowest. Brisbane (1958) reported that according to judges' scores there were no significant differences for aroma, flavor, tenderness, or juiciness of turkey rolls that were dry roasted versus those poach roasted.

Degree of doneness

Data from the Turkey Handbook (ca. 1954c) indicated that turkey was done when a thermometer placed in the center of the inside thigh muscle registered 190°F. Other ways suggested for determining the degree of doneness were: pressing fleshy part of drumstick with fingers, moving drumstick up and down, and pricking under wings with a fork.

In Cooley's (1956) investigation, judges were asked to score the degree of doneness not only of light and dark meat of turkey, but also of the juice that exuded during carving. Birds roasted to 194°F. in thigh and 185°F. in pectoralis major were significantly more done than those cooked to 185°F. in thighs. Exuded juice from turkeys during carving was considered a better indicator of the degree of doneness than sample ratings of light and dark meat. Meat and juice were scored done only when birds were roasted to 194°F. in the pectoralis major. The relationship was greater between optimum

doneness and end point temperature for the pectoralis major than it was for the thigh.

Ferguson (1957) recommended that the thermometer be placed in the breast with 194°F. the optimum end point. Judges in this study pricked the drumstick, moved the knee joint, felt the muscles of the drumstick, and noted the color and dryness of the skin in observing the general appearance. These household methods for determining degree of doneness indicated significant differences between birds cooked to the lower end points and those cooked to the higher end points. Immediately after removal of bird from the oven, doneness of meat and juice was scored on a 7 point scale. A score of four represented optimum degree of doneness with a score of seven very overdone and a score of one very underdone. Dark meat and juice in all birds did not show a significant difference. White meat from birds roasted to 194°F. in the breast and 203°F. in the thigh were scored more done ($P < .105$) than those cooked to 185°F. in the breast although the difference was not significant. Either of these two higher end points could be used as an indication of a satisfactorily done bird.

Brisbane (1958) reported that there was more variation in judges' scores for doneness of dark meat rolls than of light meat rolls. She suggested, however, that there was general satisfaction with the degree of doneness at the pre-

determined end points used. The temperatures in the center of the rolls were 185°F. for light meat and 194°F. for dark meat.

Objective Evaluation

In a study of the quality of turkey as affected by high or low density rations, Goertz et al. (1955) found a statistically significant correlation between the shear values and tenderness scores for the pectoralis major from roasted turkey halves.

Cooley (1956) reported a significant correlation between judges' scores both for tenderness and shear values, r =-0.327, and juiciness scores and press fluid, r = -0.618.

One inch cores of the pectoralis major of heavy tom turkeys were used by Ferguson (1957) to determine the shear values as measures of tenderness. She reported no correlation between the shear values and the judges' scores for tenderness of light meat.

Shannon et al. (1957), in a determination of the effect of temperature and time of scalding on the tenderness of poultry, reported that there was a high correlation between shear values using the Kramer Shear Press and judges' scores for chewing as an evaluation of tenderness.

EXPERIMENTAL PROCEDURE

The first part of this investigation was undertaken (1) to determine the rise in temperature during roasting of light meat and dark meat turkey rolls, (2) to investigate the degree of doneness of light meat and of dark meat rolls dry roasted at different oven temperatures, (3) to obtain information to use as a basis for the selection of the internal temperature for cooking the turkey rolls in the second part of the experiment, and (4) to determine the yield of edible meat and total cooking losses of turkey rolls. Oven temperatures used for cooking the rolls were 250, 300, and 350°F. Internal temperatures for light meat rolls were 176 and 185°F. and for dark meat rolls 185 and 194°F.

The second part of the study was concerned primarily with a comparison of the flavor, aroma, tenderness, and juiciness of whole turkey with that of light meat and of dark meat turkey rolls. Yield of edible meat and total cooking losses were obtained for whole turkey and turkey rolls. Light meat rolls, dark meat rolls, and whole turkeys were cooked at an oven temperature of 300°F. The experimental plan was to roast light meat rolls to an internal temperature of 176°F., dark meat rolls to 185°F., and whole turkeys to 185°F. in the thigh muscle.

Methods and Materials

History of the turkeys

Blast frozen, oven-ready, Grade A tom turkeys, 20-22 pounds, and six months of age were used in this study. These Broad Breasted Bronze turkeys from the same flock had all received a similar ration. The birds were processed at Ellsworth Cooperative, Ellsworth, Iowa, on January 2 and 3, 1957. On the latter date the turkeys were shipped to Iowa State College in a refrigerated truck and stored at Food Stores in a walk-in freezer at a temperature of -10°F. until time for experimentation. Thus age, breed, feed, and processing were uniform for the turkeys used in this study.

Thawing and deboning procedure

For each replication, two turkeys were thawed at 39±1°F. for approximately 72 hours in a walk-in refrigerator in the Institution Management Department. Then each turkey was deboned: a light meat roll was prepared from breast meat and a dark meat roll was prepared from thigh and adjoining back meat.

In the deboning procedure, which was similar for all birds, a sharp boning knife was used. Wings were removed at the joint adjacent to the body, cutting around the joint to leave as much meat as possible on the breast. Legs were removed at the joint between the thigh and the drumstick. After

removal of wings and legs, the skin was removed in two sections, one from the breast side and the other from the back. The lower half of the carcass containing the thighs was cut free from the remaining part of the carcass by cutting as close as possible to the end of the breast bone and through the back bone. This divided the carcass into two sections. The light meat was removed by making an incision parallel to and on each side of the backbone. Then cutting closely to the ribs and to the keel bone, flesh was removed in two parts, one from each side of the breast. For the boneless dark meat, the muscle of dark meat from the back (sometimes called the "oyster") was removed by loosening the flesh with the tip of the knife curving down into the spoon shaped cavity of the backbone. The thigh bone was removed from the muscles.

Preparation of the turkey rolls

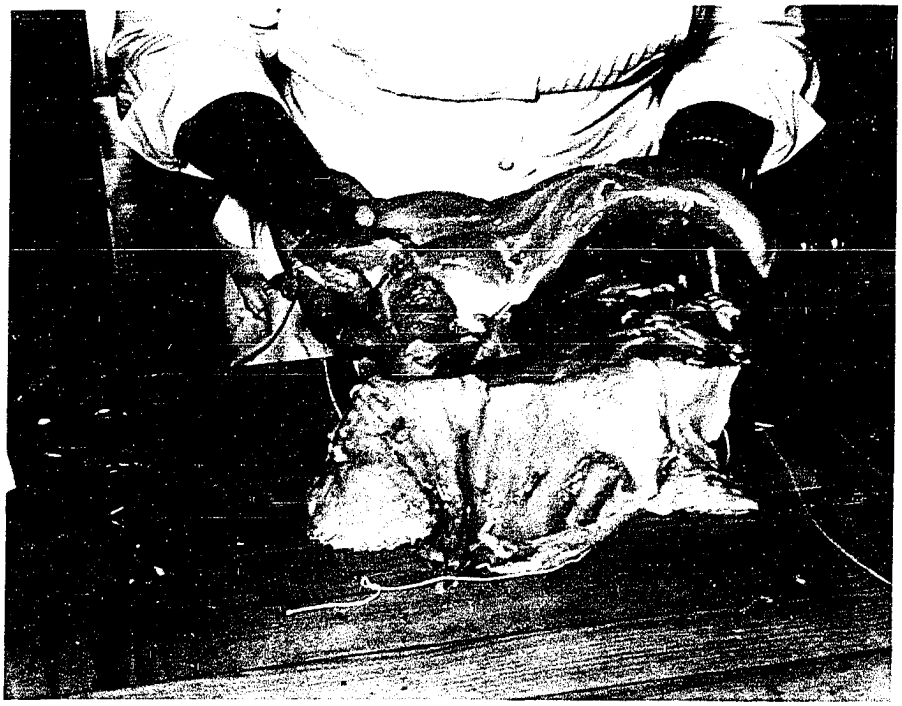
An aluminum loaf pan (9 x 4 1/2 x 2 3/4 in.) served as a mold to standardize the size and shape of the light meat rolls. Four pieces of cord that were used for tying the roll were placed in the mold, three crosswise and one lengthwise. Skin that had been removed from the breast side of the turkey was placed in the mold. The right breast muscle was placed in the mold, cut side up, with the caudal end or small part of the muscle toward one end of the pan. The left breast muscle was placed in the mold, cut side down, with the caudal

end toward the opposite end of the pan as illustrated in Figure 1. The skin was brought together over the breast muscles, sewed, and tied to form a roll. Any excess skin was trimmed.

The smaller mold needed for the dark meat rolls was made from a 46 ounce (No. 5) can which was inserted into the aluminum loaf pan used for the light meat rolls. After removing one disc end, the can was split along the seam and approximately one third around the remaining disc end. The can was opened and bent down so that no raw edges were exposed and it rested firmly in the loaf pan. The three pieces of cord used for tying were placed in this mold, two crosswise and one lengthwise. Next the skin from the back was placed in the mold. Dark meat from each half of the bird was cut into two pieces separating the back muscles from the thigh muscles. The paired muscles from the back were placed lengthwise in the bottom of the mold, cut sides up. The paired thigh muscles were placed next in the mold, cut sides down. Then the skin was drawn over the muscles, sewed, and tied to form a roll. Excess skin was trimmed.

Both light meat and dark meat turkey rolls were wrapped in pliofilm wrappers to prevent dehydration. These rolls were stored over night in a refrigerator (40°F.) in the Food Evaluation Laboratory.

Figure 1. Preparation of light meat roll



Cooking of the turkey rolls

Before and after cooking, the rolls were weighed and measured for length, width, depth, and girth. Data were obtained according to the procedure listed in AppendixA,Figure 21.

Turkey rolls were dry roasted in a shallow pan on a rack at oven temperatures set for 250, 300 or 350°F. in a Despatch and in a Frigidaire oven. Aluminum pans (9 x 14 x 2 1/2 in.) were used for light meat rolls and (8 x 12 x 2 in.) for dark meat rolls. A 2 x 3 factorial design was used that provided for the evaluation of light meat and dark meat rolls cooked to two internal temperatures but at only one oven temperature for each replication (Table 8). Four replications were used for each end point (176 and 185°F. for the light meat and 185 and 194°F. for the dark meat) at each of the three oven temperatures (250, 300, and 350°F.). Roasting of light meat and dark meat rolls was alternated between the Frigidaire and the Despatch ovens as shown in Table 8.

Temperatures of the turkey rolls and of the ovens were recorded at 15 second intervals on an eight-point Brown-Honeywell recording potentiometer (Model No. 153x60P8-X-31F1). The thermocouple connections were changed at the switch box at approximately 20 minute intervals. According to this procedure, eight temperatures could be recorded in the Frigid-

aire oven alternately with eight temperatures in the Despatch oven. The thermocouples and a thermometer were inserted to record temperatures at fixed points within the rolls (Figure 2a). Rolls were removed from the oven when the predetermined end point was reached in position No. 3, the center of the roll. For rigidity and ease of insertion, thermocouple wires (iron-constantin) were welded into pointed stainless hypodermic needles 4 inches long which had been scored at 1 inch intervals as shown in Figure 2b.

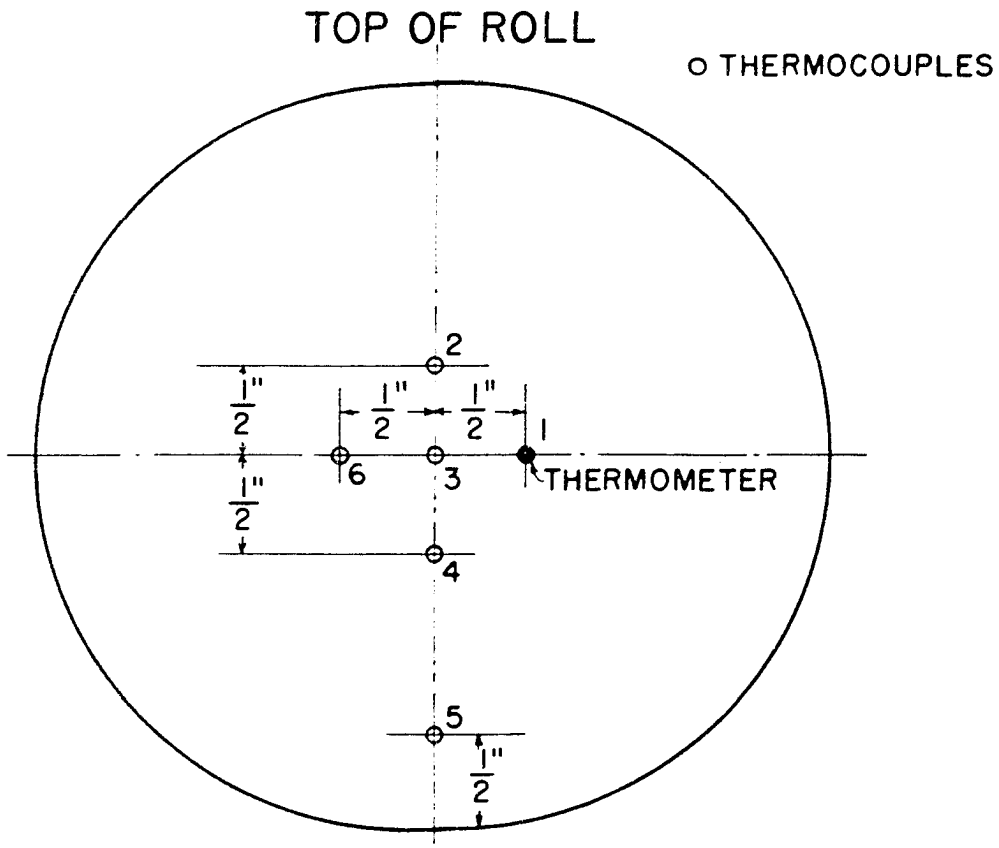
Table 8. Schedule for roasting turkey rolls[a]

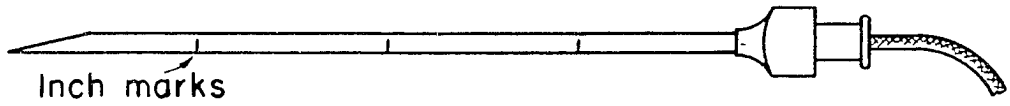
Type of oven	Internal end point	Oven temperature	Type of oven	Internal end point	Oven temperature
	°F.	°F.		°F.	°F.
Light meat roll			Dark meat roll		
Frigidaire	176	250	Despatch	185	250
		300			300
		350			350
	185	250		194	250
		300			300
		350			350
Despatch	176	250	Frigidaire	185	250
		300			300
		350			350
	185	250		194	250
		300			300
		350			350

[a] This series was repeated for the 24 light meat rolls and for the 24 dark meat rolls prepared from the 24 turkeys.

Figure 2a. Diagrammatic section of roll showing points at which temperatures were recorded

Figure 2b. Thermocouple used in experiment





THERMOCOUPLE

Preliminary experiments were conducted on 25 turkeys to determine the cooking time of turkey rolls dry roasted to specific end points at various oven temperatures. These data were used as a basis for estimating the roasting time of the rolls to the predetermined end points.

Total cooking yields and losses for rolls were calculated. Weights and measurements were taken of the drippings. Volatile losses were calculated as the difference between the total cooking losses and the drip losses. Percents for yields and all losses, total, drip, and volatile, were calculated on the basis of the weight of the uncooked roll.

Cooking of the whole turkey and rolls

Preliminary experiments were conducted on eight turkeys to determine the cooking time for whole turkey dry roasted to a specific end point. Data recorded were summarized and used as a basis for selection of roasting time and cooking schedule for whole birds.

Before and after cooking, whole turkeys and turkey rolls were weighed. In addition, turkey rolls were measured. At an oven temperature of 300°F., light meat and dark meat turkey rolls were dry roasted to internal temperatures of 176 and 185°F. respectively. For the whole turkey, a thermometer

was inserted in the thigh, but thermocouples were inserted in each breast and thigh (Figures 3a and 3b). Final internal temperatures varied for whole turkeys as may be seen in the results, although the plan was to roast whole turkeys until a temperature of 185°F. was reached in the thigh muscle.

Yields and losses, total, drip, and volatile, were calculated according to the procedure used in Part I of the study. Yields and cooking losses for the whole turkeys were calculated on the basis of the weight of the ready-to-cook bird.

Subjective Evaluation

After the rolls had cooled for approximately 15 minutes, samples 1/4 inch thick were machine sliced on a Hobart slicer (Model No. 411). Slices of light meat and dark meat were served on heated porcelain plates to a panel of seven judges in booths especially designed for organoleptic tests located in the Food Evaluation Laboratory (Figures 4a and 4b). Four samples from the same location, one from each of the rolls cooked to the predetermined internal temperatures previously described, were scored by each judge. The two light meat samples were presented first and the two dark meat samples presented second. Each day the location of the samples for a specific judge was from a different section of the roll to enable him to evaluate various parts of the cooked meat.

Figure 3a. Placement of thermocouple in raw whole turkey

Figure 3b. Location of thermometer and thermocouple in cooked whole turkey

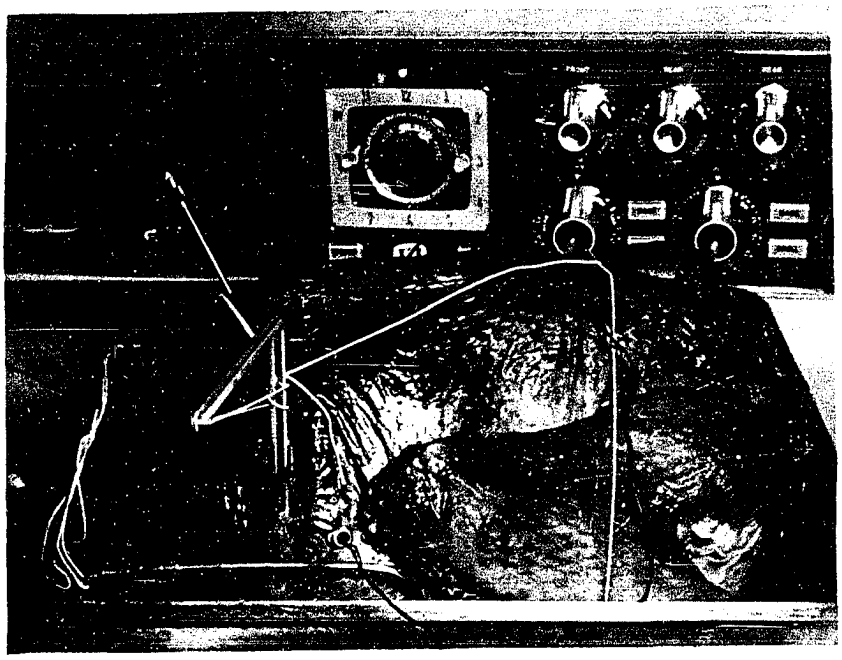
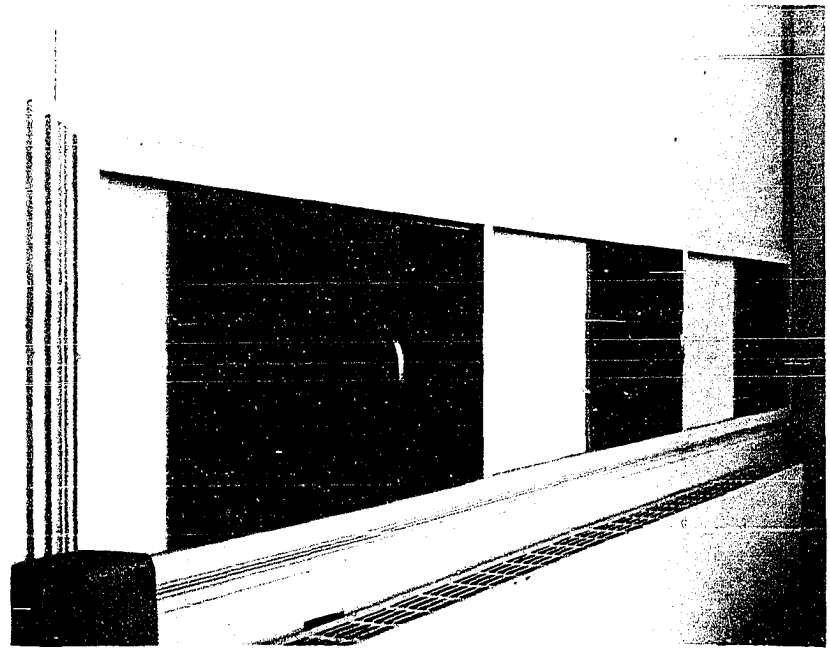
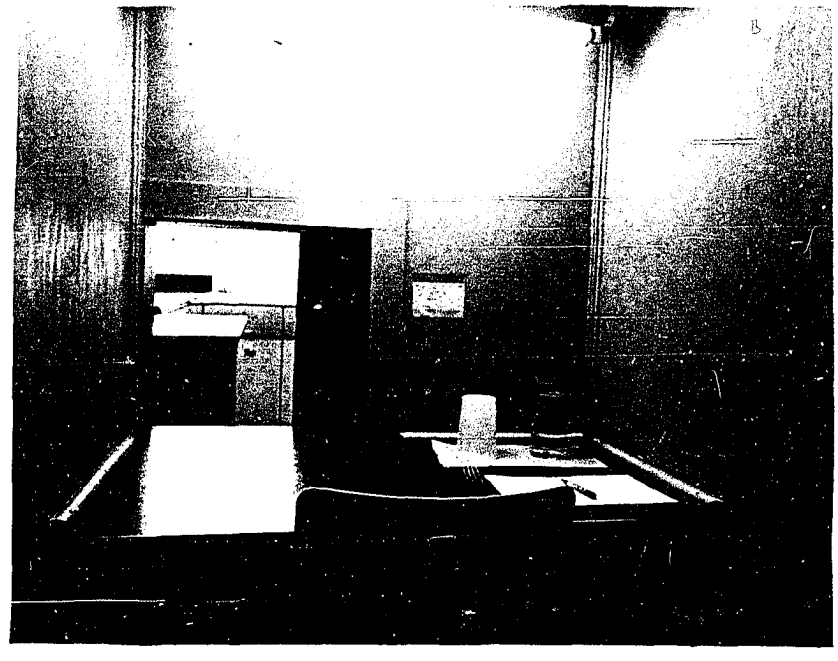


Figure 4a. Exterior of organoleptic booths

Figure 4b. Interior of organoleptic booths





In a preliminary test for the selection of judges, out of a group of twenty individuals, seven judges were chosen on the basis of their ability to detect differences in the quality factors of roasted turkey. A total of 25 turkeys were used to train the members of the group. The characteristics of the quality factors to be evaluated were defined and discussed so that there was a general understanding of procedures involved.

Cooked whole turkey was deboned according to the method previously described for the raw turkey before samples from it were presented to the judges for comparison with the turkey rolls. The cooked turkey rolls were opened so that comparable breast and thigh muscles were sliced in the same manner as was the cooked whole turkey. Light meat from both the whole turkey and the roll was machine sliced, whereas the dark meat was hand sliced. Care was exercised so that each judge received a similar slice from the same location for the light and dark meat of both the cooked whole turkey and the rolls.

Seven judges scored the coded samples of rolls and whole turkey for aroma, flavor, tenderness, and juiciness. Numerical scores of 0-10 were given with the highest score of 10 indicating maximum intensity of turkey flavor, aroma, tenderness and juiciness. The score of zero indicated a lack of these characteristics. In addition judges were asked to indicate

whether the meat was considered underdone, done, or overdone. A sample score card is shown in the Appendix A, Figure 22.

Objective Evaluation

Samples used to measure shear force were obtained from the pectoralis major muscle by boring with a sharp edge metal cylinder, 1/2 inch in diameter, through the cooked muscle at the caudal and cranial ends. Samples were obtained on alternate days from both the left and the right pectoralis major muscles of turkey used in light meat rolls roasted to two end points. This provided for 12 samples, two for each treatment. With the modified Warner-Bratzler shearing apparatus, two successive shears were made on the core from the cranial end and one on the core from the caudal end. The readings were averaged for the caudal and cranial cores from left and right muscles for each roll tested.

RESULTS AND DISCUSSION

Weight Losses Prior to Cooking

There was very little variation in the as purchased weight of turkeys used in this investigation. The 24 frozen Broad Breasted Bronze turkeys used in the first part of the study varied in weight from 9875 grams (21.8 pounds) to 9080 grams (20.0 pounds) with an average of 9501 grams (20.9 pounds) and a standard deviation of 288 grams (0.6 pound). The as purchased weights of the 12 birds used in the second part of the investigation varied from 9960 grams (21.9 pounds) to 9137 grams (20.1 pounds) with an average of 9598 grams (21.1 pounds) and a standard deviation of 334 grams (0.7 pound). In both cases the weights of the birds were not clustered about the mean but were well distributed throughout the entire range. Individual weights of the whole frozen turkeys are recorded in Appendix A, Table 31.

Losses during frozen storage

Weights of frozen birds were taken as they were removed from the walk-in freezer. In every case the weight checked with that marked on the Cry-o-vac wrapper by the processor. This indicated the reliability of the weights of the turkeys from the turkey processing plant. Also, and of prime importance to this study, there was no loss in weight during frozen storage.

Defrosting losses

Weights of the whole turkey were taken before and after the thawing period. Thawing losses for all birds were small, and the differences in the amount of losses among birds were negligible after a period of 72 hours. Thawing losses varied from 170 grams to 85 grams with an average of 96 grams (3.4 ounces or 0.21 pound), or approximately 1 percent of the as purchased weight for the 24 turkeys that were to be deboned and rolled. Thawed weights of the six turkeys used for roasting whole in the second part of the study were taken immediately prior to roasting, 96 hours after removal from the freezer. Thawing loss of 114 grams (4 ounces or 0.25 pound) was the same for all six of the turkeys. This loss represents an increase of only .04 pound for the additional 24 hours of thawing. Thawing losses for each of the six birds used for preparing rolls in the second part of the study were 85 grams (3 ounces or 0.19 pound) after the 72 hours thawing time.

Crowe (1957), who used turkeys from the same flock and thawed under similar conditions, reported a loss of 2.1 ounces for 65 $\pm$ 1 hours thawing time; whereas, in this investigation the thawing loss was 3.4 ounces for 72 hours thawing time.

Thawing losses reported by Brisbane (1958) were 2.1 ounces smaller than those in this investigation for the 20 to 22 pound ready-to-cook birds thawed 72 hours in the same

refrigerator used by Crowe (1957) and the present investigator. The difference in source of birds may account for the decrease in thawing loss found by Brisbane.

Thawing losses of 1 percent for birds in this study were considerably less than the 3.3 percent average losses reported by Larson (1956). In her study, thawing losses ranged from 6.4 to 1.4 percent; however, these percents were determined for only 4 frozen eviscerated pan-ready turkeys with a weight range of 21.0 to 19.3 pounds, while losses in this study were the average from 36 turkeys. Also, in a comparison of the thawing losses found by Larson with those reported in this study it must be considered that turkeys in her study were thawed 4 hours at room temperature and 48 hours under refrigeration.

Yields of Raw Meat

The weights of the raw muscles of breast, thigh, and adjoining back that were used in the preparation of the rolls may be seen in the Appendix A, Tables 32, 33, and 34. Weights for parts of turkeys are shown in Appendix A, Table 35. Average weights and ranges in weights of the raw muscles and rolls are summarized in Table 9.

The skin used in preparation of rolls averaged 0.9 pound for light meat rolls and 0.4 pound for dark meat rolls. In

Table 9. Average weights of raw muscles and rolls

	Part I		Part II	
	Weight range	Average	Weight range	Average
	lbs.	lbs.	lbs.	lbs.
Breast muscle	6.2 to 4.5	5.5	6.1 to 4.8	5.6
Light meat rolls	7.1 to 5.3	6.4	7.2 to 5.6	6.5
Back and thigh muscle	2.8 to 2.2	2.4	2.5 to 2.2	2.4
Dark meat rolls	3.2 to 2.6	2.8	3.1 to 2.6	2.8

weighing the parts of the turkeys, a scale calibrated in grams was used. Therefore, all pound weights given in the tables have been converted from gram weights. Percents reported in this study were calculated from the gram weights. The light meat rolls averaged approximately 2 1/4 times the weight of the dark meat rolls (Table 9). Weights for individual rolls are given in Appendix A, Tables 32, 33, and 34. The relation of the weight of raw muscles used in the rolls to the weight of the whole turkey is shown in Table 10.

Table 10. Percent of raw muscles used in rolls based on the weights of uncooked birds

Turkey	Turkey	Breast		Thigh and back	
	lbs.	lbs.	%	lbs.	%
Whole, frozen					
Part I	20.9	5.4	26.5	2.4	11.4
Part II	21.1	5.6	26.5	2.4	11.1
Whole, thawed - giblets and neck					
Part I	18.9	5.4	29.3	2.4	12.6
Part II	19.1	5.6	29.4	2.4	12.3

The range in weights of raw light meat rolls was 7.1 to 5.3 with an average of 6.4 pounds (Table 8). These weights compared favorably with those of Brisbane (1958), who reported a range of 7.9 to 6.0 pounds with an average of 7.1 for light meat rolls, since rolls prepared by Brisbane included not only breast meat, as used by the present investigator, but also meat from the first joint of wings which added approximately 0.5 pound to the total weight.

Linear Measurements of Rolls

Linear measurements of the rolls varied although molds were used to help standardize the size. In spite of being tied lengthwise, when rolls were removed from the molds, they flattened out so that the length measurements were greater than the length of pans used during shaping. Differences in weight and shape of birds contributed to this variation. Measurements for the individual raw and cooked rolls may be found in Appendix A, Tables 36 and 37. Size and shape of rolls are illustrated in Figure 5. Average measurements and standard deviations for the rolls are shown in Table 11.

As may be seen from data on cooked light and dark meat rolls (Table 11), rolls did not shrink uniformly in all dimensions. In general, depth increased, whereas the length, width, and girth lengthwise decreased. Girth widthwise remained approximately the same.

Figure 5. Raw light meat and dark meat rolls

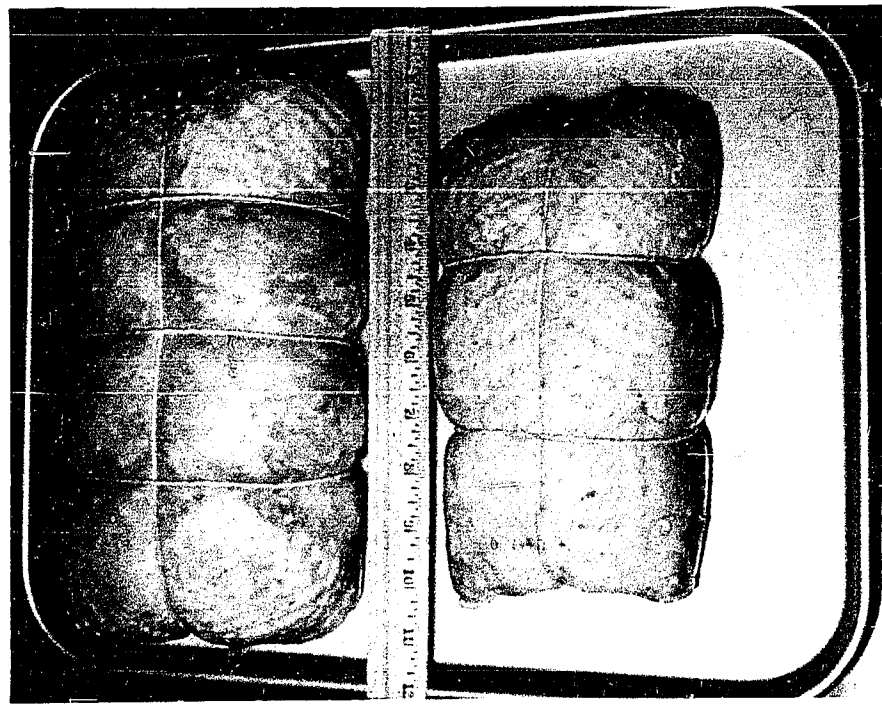


Table 11. Average measurements and standard deviations for light meat and dark meat rolls

Rolls	Depth inches		Length inches		Width inches		Girth lengthwise inches		Girth widthwise inches	
	Av.	s	Av.	s	Av.	s	Av.	s	Av.	s
Light meat										
Raw	3.6	.2	10.5	.3	6.0	.4	25.2	.9	16.0	.6
Cooked	4.1	.3	9.1	.5	5.4	.4	22.9	1.0	16.1	.6
Dark meat										
Raw	2.9	.2	8.0	.3	4.5	.1	18.9	.5	12.6	.6
Cooked	3.3	.4	6.6	.3	4.1	.2	16.6	.6	12.4	.7

Oven Temperature Variability

Variations in oven temperatures are important in measurements of cooking time, thus thermocouples were used to record oven temperatures. A summary was made and the results indicated that when ovens were set for 250, 300, or 350°F., the average temperatures in the Frigidaire oven were 262, 305, and 355°F. and in the Despatch oven, 259, 307, and 346°F., respectively.

When the ovens were set for 250 and 300 °F., the average oven temperatures differed by 3 and 2°F. respectively, whereas, at 350°F., the average temperatures of the two ovens differed by 9°F. The ranges in temperatures are given in Appendix A, Table 38. While the temperatures dropped considerably when doors were opened to insert or remove a roll, recovery of oven

temperature occurred within approximately 2 minutes.

Part I. Roasting Light Meat and Dark Meat Rolls

Numerous investigations have verified the following factors as affecting the roasting of turkey: (a) weight of the bird, (b) shape of the bird, (c) fat deposition, (d) composition of the meat, (e) initial temperature of the bird, (f) cooking temperature, (g) method of preparation and cooking, and (h) degree of doneness.

Rise in temperature

Within light meat and dark meat rolls, there was slight variation in the initial temperatures recorded for the five specific points within a roll. However, considerable variation was found in the final temperatures. It can be said with reasonable certainty that the temperatures reported were for the specific points described in the procedure because of the type of thermocouple used (Figure 2b). It may be well to recall that position No. 3 was at the center of the roll (Figure 2a). The temperature at this position was used as the final internal temperature for the rolls. The other points used for recording temperature were No. 2, 1/2 inch above center; No. 4, 1/2 inch below roll center; No. 5, 1/2 inch up from bottom of roll below center; and No. 6, 1/2 inch left of center. Total cooking time and the average rise in temperature at these specific points in relation to oven temperatures

are presented in Tables 12 and 13.

It can be seen from the data illustrated in Figures 6, 7, and 8 that the general pattern of the temperature rise in light meat rolls during cooking was similar for all points within a roll at any given oven temperature.

Figure 6 shows graphically that although initially or during first part of cooking there was a rapid rise in temperature at position No. 5, which is very near the bottom of the pan, after approximately one hour the rate of rise decreased in such proportion that, in general, the final temperature in position No. 5 was lower than the temperature at all other points. An examination of the data in Tables 12 and 13 reveals that the warm-up period for the center of the roll, at position No. 3, was longer than that for all other points; however, the final end point was between those recorded for points above and below center.

It should be noted, however, from the data in Table 12 that variation occurred in the rate of temperature rise in different parts of the roll. A comparison can be made of the differences in the rate of rise in the center of the rolls, cooked at 250, 300, and 350°F. (Figure 9). The slopes of the curves are typical for roasts cooked at different oven temperatures. The initial period, during which the heat penetrated the muscles, warming up the light meat rolls, was approxi-

Table 12. Average rise of temperature at five specific points for light meat rolls

Time interval	Oven temperatures: 250°F. Points at which temperatures were recorded: 2	3*	4	5	6	300°F. 2	3*	4	5	6	350°F. 2	3*	4	5	6
Minutes	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
0	36	35	36	38	36	35	34	38	39	38	34	34	37	37	35
10	38	37	37	41	37	38	36	40	40	40	37	36	41	41	38
20	41	38	38	44	38	43	38	41	41	44	40	39	46	45	41
30	47	42	41	51	43	46	41	47	46	50	46	45	52	48	47
40	52	46	44	55	48	53	45	51	50	55	54	51	57	57	55
80	77	74	65	76	71	86	73	81	75	90	96	87	85	85	99
120	104	98	90	100	96	119	109	112	103	122	133	121	119	117	134
160	126	121	112	114	120	146	135	134	127	150	164	151	149	144	162
195	--	--	--	--	--	--	--	--	--	--	183	176	174	174	182
198	--	--	--	--	--	--	--	--	--	--	190	185	178	177	191
200	144	139	128	128	140	169	156	156	150	170					
238	--	--	--	--	--	190	176	176	169	185					
239	--	--	--	--	--	191	185	185	183	188					
240	159	154	144	144	152										
280	169	164	157	154	164										
320	182	176	172	163	176										
347	191	185	181	175	183										

*Point used for indicating predetermined end points

Table 13. Average rise of temperature at five specific points for dark meat rolls

Time interval minutes	Oven temperatures: 250°F. Points at which temperatures were recorded: 2	3*	4	5	6	300°F. 2	3*	4	5	6	350°F. 2	3*	4	5	6
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
0	41	38	40	40	40	36	37	38	41	38	39	37	36	39	38
10	45	40	44	44	45	41	40	41	43	43	43	41	41	42	42
20	52	44	47	48	50	48	44	45	48	52	52	47	45	48	50
30	63	51	53	55	58	59	54	53	55	64	63	61	57	59	60
40	73	57	59	65	70	72	66	60	65	82	83	70	72	68	73
80	112	105	96	99	105	121	114	102	105	126	148	134	127	118	137
120	142	136	132	129	139	163	155	151	148	169	197	178	168	172	176
135	---	---	---	---	---	---	---	---	---	---	198	185	181	183	191
138	---	---	---	---	---	---	---	---	---	---	206	194	183	184	195
155	---	---	---	---	---	192	185	173	177	188					
160	167	159	154	154	163	186	186	174	178	188					
167	---	---	---	---	---	201	194	186	190	201					
200	180	172	170	169	178										
225	186	185	173	175	187										
250	200	194	189	188	197										

*Point used for indicating predetermined end points

Figure 6. Rise in temperature for light meat and dark meat rolls roasted at oven temperature 250°F.

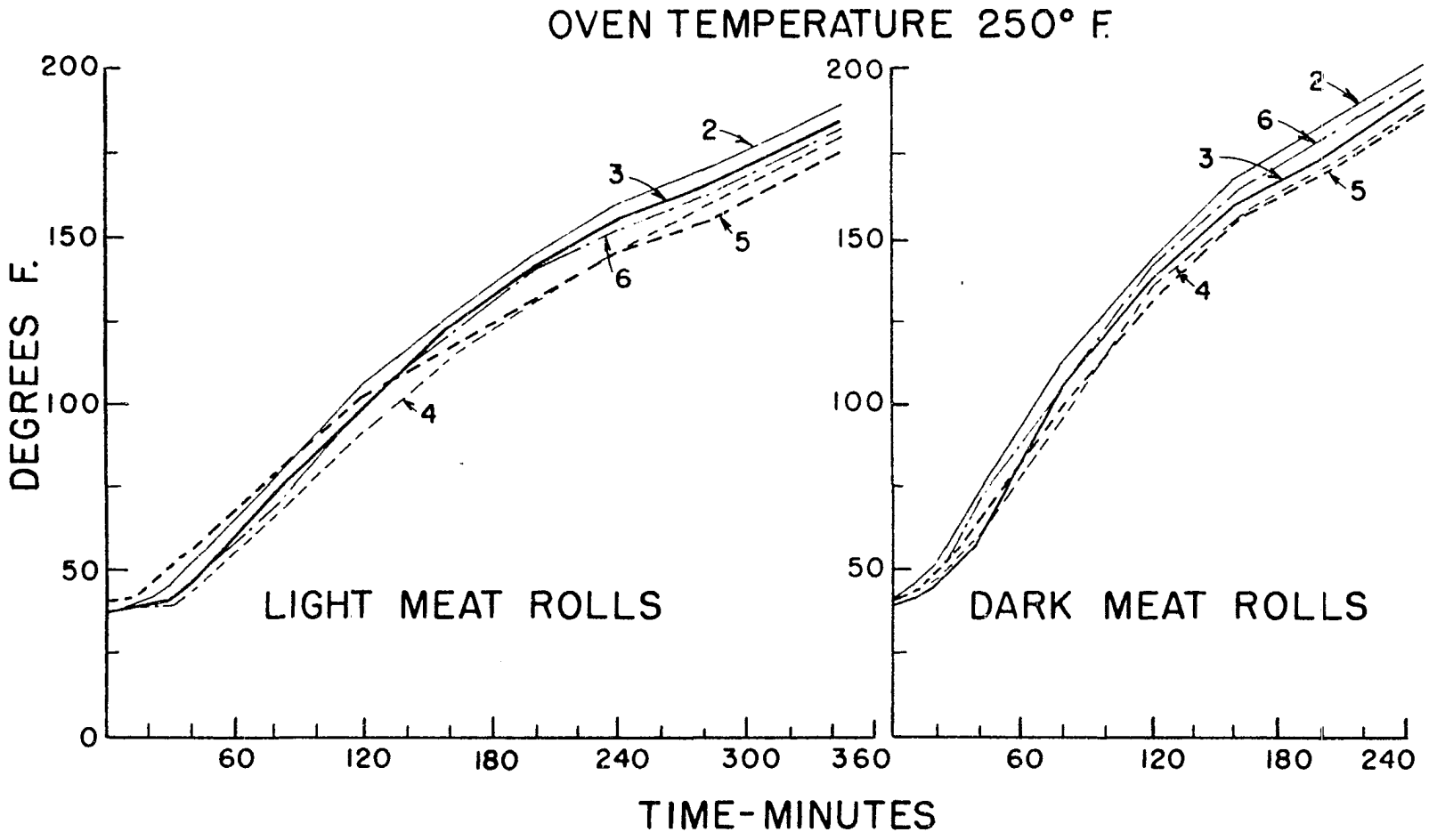

OVEN TEMPERATURE 250° F.
DEGREES F.
200
150
100
50
0
2
3
4
5
6
LIGHT MEAT ROLLS
60
120
180
240
300
360
DARK MEAT ROLLS
TIME-MINUTES

Figure 7. Rise in temperature for light meat and dark meat rolls roasted at oven temperature 300°F.

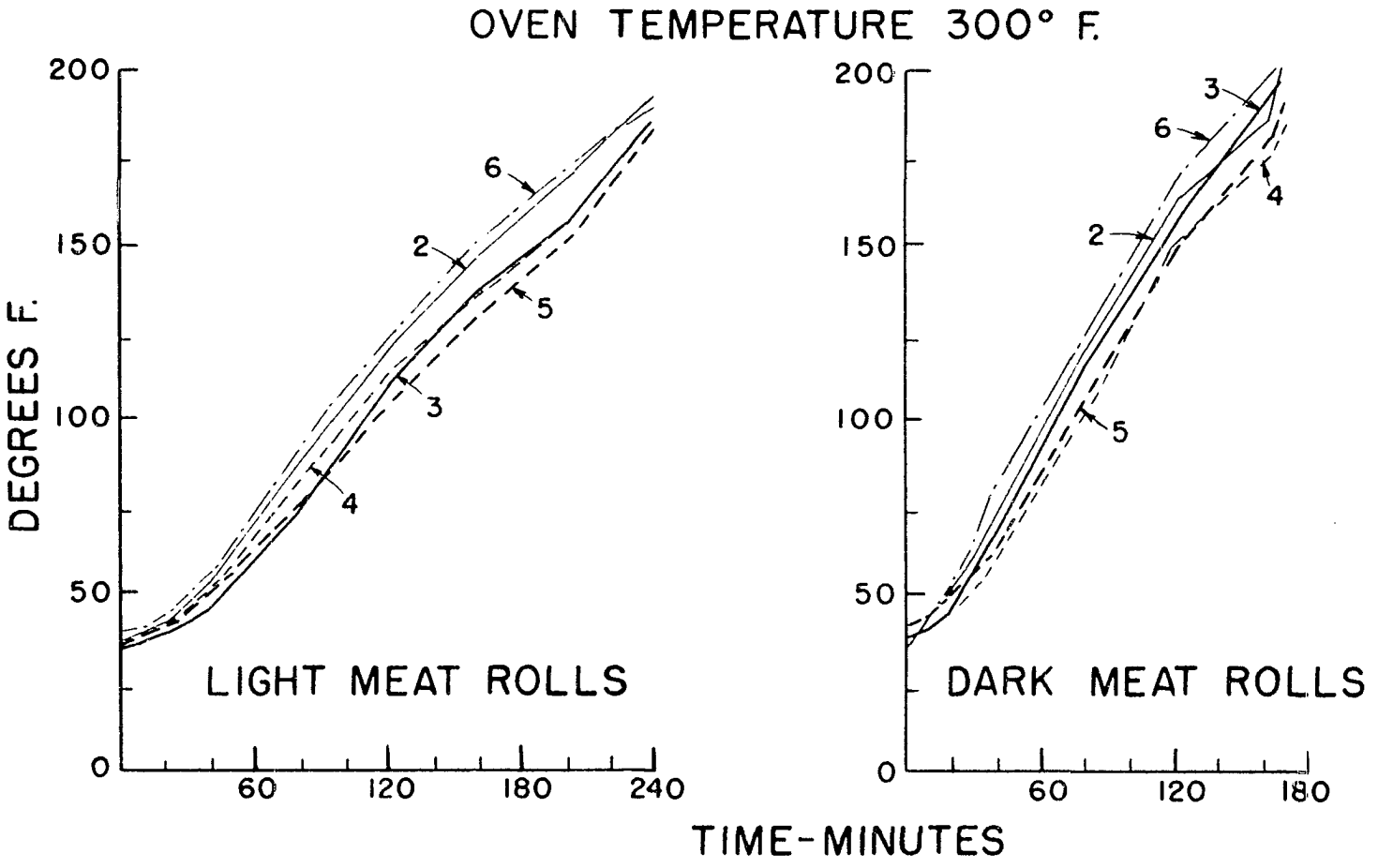
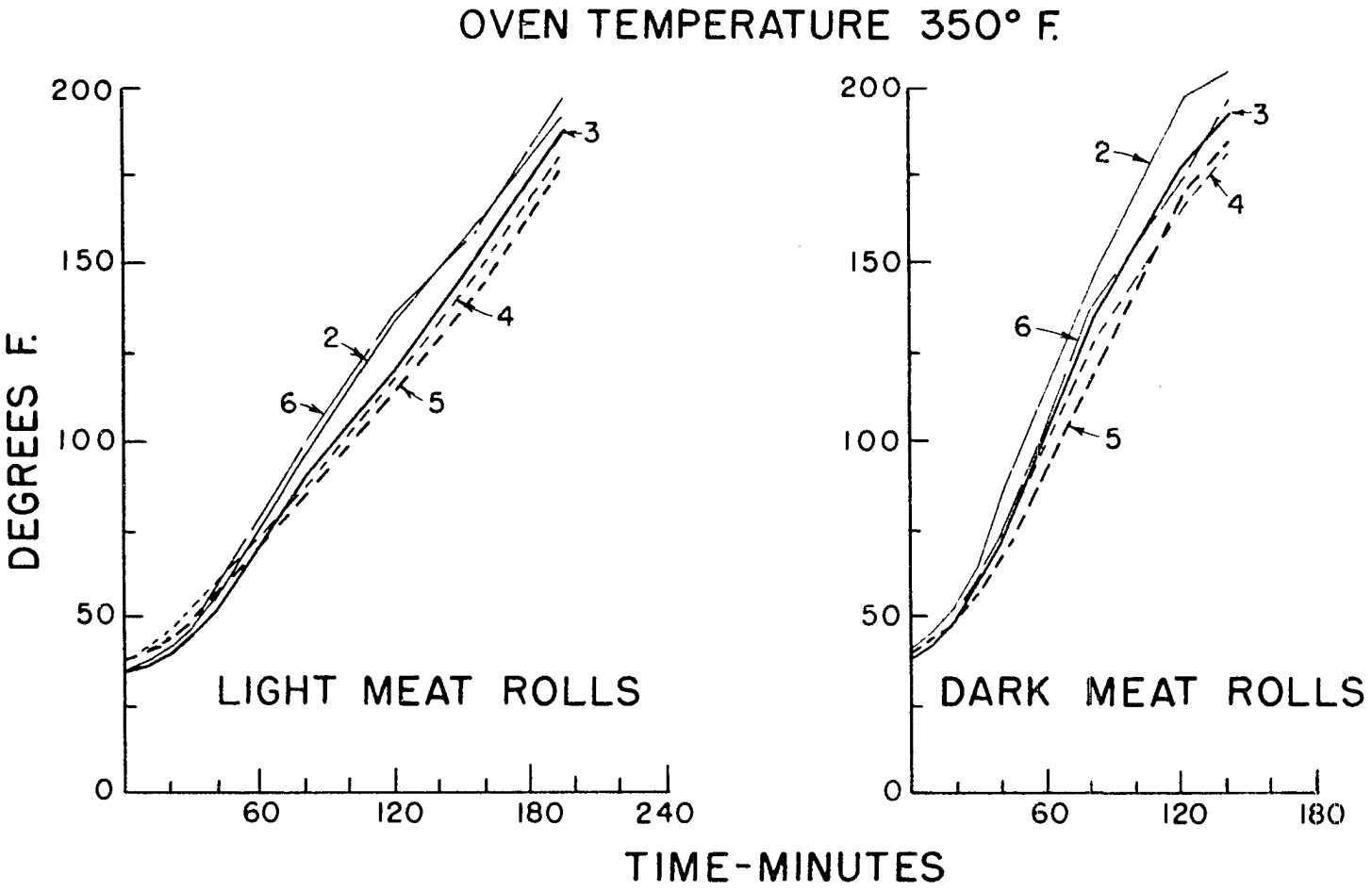

OVEN TEMPERATURE 300° F.
DEGREES F.
200
150
100
50
0
60
120
180
240
6
2
5
3
4
LIGHT MEAT ROLLS
3
6
4
2
5
DARK MEAT ROLLS
TIME-MINUTES

Figure 8. Rise in temperature for light meat and dark meat rolls roasted at oven temperature 350°F.


OVEN TEMPERATURE 350° F.
DEGREES F.
200
150
100
50
0
60
120
180
240
2
3
4
5
6
LIGHT MEAT ROLLS
DARK MEAT ROLLS
TIME-MINUTES

mately 30 minutes for oven temperatures of 250 and 300°F. and 20 minutes for 350°F.; after this period there was a rapid rise in the interior temperature. An examination of the data in Figures 6, 7, and 8 shows that when the higher oven temperatures were used, the rate of rise in the internal temperatures was more rapid. Lowe (1955, p. 238) stated:

> The higher the cooking temperature the more rapidly will a piece of meat reach a definite temperature, for, with a higher temperature at the surface, the more rapidly heat will penetrate to the interior of the meat. As cooking temperatures may vary many degrees, this factor causes a wide variation in the time required.

The slope of the curves for light meat and dark meat rolls increased in steepness as the oven temperatures increased; at 350°F. it was highest and at 250°F., lowest (Figures 6, 7, and 8). The rapid rise, which began after 30 minutes cooking time at oven temperatures 250 and 300°F., was followed by a period of slower rise during which the proteins were probably coagulating (Table 12). The slopes of the curves that indicated the rise in temperature decreased during coagulation and showed evidence that coagulation proceeds at a much slower rate at low oven temperatures than it does at high oven temperatures. At low oven temperatures, coagulation takes place over a fairly wide temperature range. At oven temperature 250°F. (Figure 6), the slopes of the curves showed a definite leveling after 120 minutes cooking time at which time the range in temperatures within the rolls was approximately 90 to 103°F. The rate of rise from this time until

the end of cooking was decidedly less than that between 30 and 120 minutes.

At an oven temperature of 300°F. (Figure 7), the general pattern of the curves was similar but very steep. The change in slope was much less pronounced but appeared to be between 80 and 120 minutes cooking time at which time the range of temperatures within the roll varied from 105 to 120°F. At 350°F. (Figure 8) after the initial warm up period, the slope of curve was very steep and the change in rate was much less noticeable. It was difficult to mark the beginning of the coagulation period.

An examination of the data in Figures 6, 7, and 8 reveals that in dark meat rolls the slopes of the curves were similar when rolls were cooked at the three oven temperatures. Although the slopes of the curves were most steep at 350°F., it was difficult to determine when coagulation began. The warm up period was quite pronounced, 20 minutes at oven temperatures 250 and 300°F. and 15 minutes at 350°F., after which there was a rapid rise in the internal temperatures. The data presented in Tables 14 and 15 give the rate of temperature rise at 40 minute intervals of cooking.

The curves in Figure 9 illustrate the rate of rise in the center of light meat and dark meat rolls roasted at the

Table 14. Average rate of temperature rise in light meat rolls at 40 minute intervals

Minutes	250°F.					300°F.					350°F.				
	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6
0-40	16	11	8	17	12	18	11	13	11	17	20	17	20	20	20
40-80	25	28	21	21	23	33	28	30	25	35	42	36	28	28	44
80-120	27	24	25	24	25	33	36	31	28	32	37	34	34	32	35
120-160	22	23	22	14	24	27	26	22	24	28	31	30	30	27	28
160-200	18	18	16	14	20	23	21	22	23	20					
200-240	11	15	16	16	12										
240-280	10	10	13	10	12										
280-320	13	12	15	9	12										

Table 15. Average rate of temperature rise in dark meat rolls at 40 minute intervals

Minutes	250°F.					300°F.					350°F.				
	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6
0-40	32	19	19	25	30	36	29	22	24	44	44	33	36	29	35
40-80	39	48	37	34	35	49	48	42	40	44	65	64	55	50	64
80-120	30	31	36	30	34	42	41	49	43	43	49	44	41	54	39
120-160	25	23	22	25	24	23	31	23	30	19					
160-200	13	13	16	15	15										

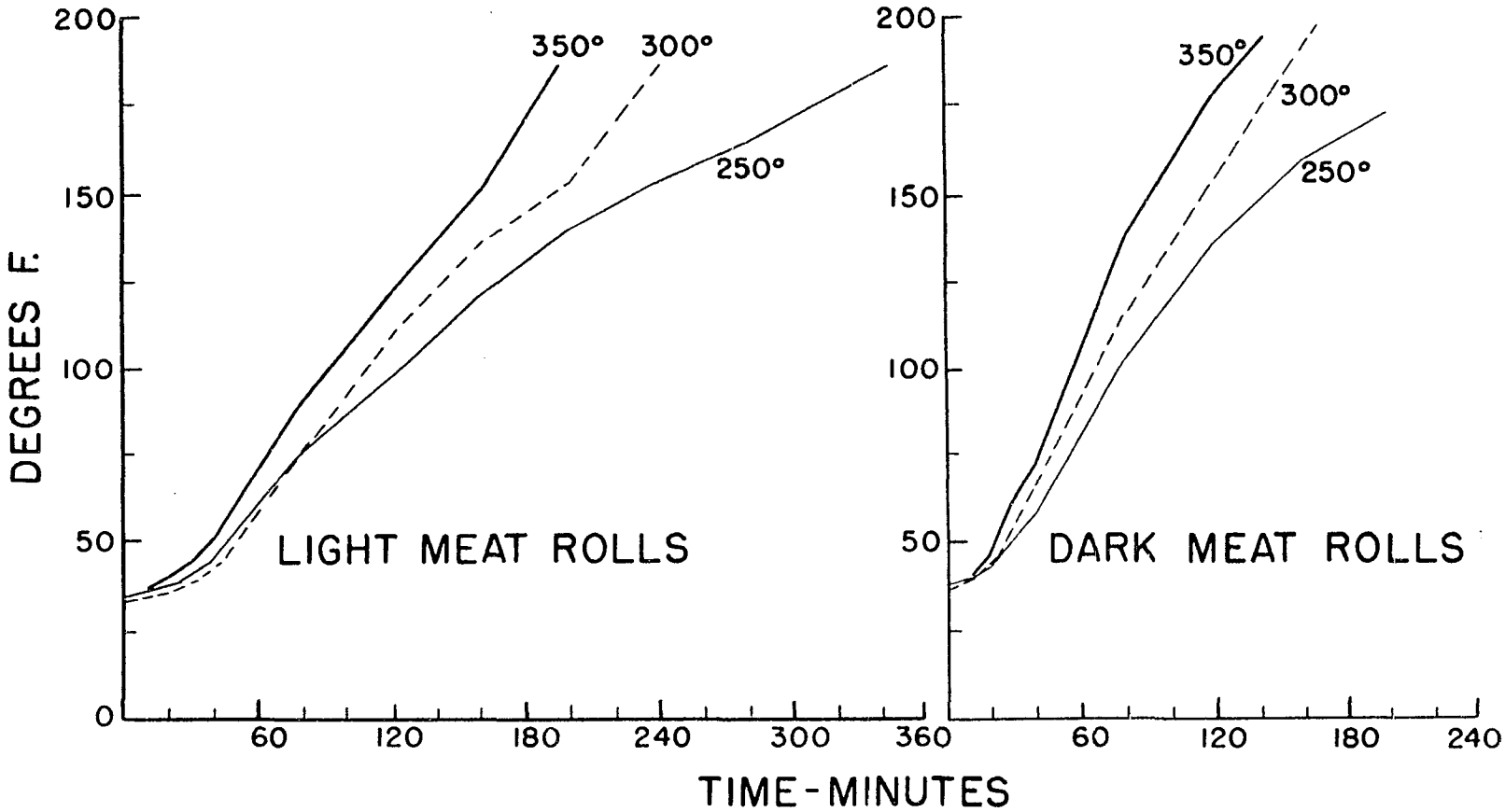
three oven temperatures. The slopes of the curves indicate the variation among the rolls in the rate of rise at this specific point. The leveling of the curve at an oven temperature of 250°F. is probably indicative of protein coagulation. At higher oven temperature this phase in cooking is much less noticeable.

A comparison of the final temperatures at the end of the average total cooking time as presented in Tables 12 and 13 showed that there was considerable variation in the rate of rise and in the final end points at the specific locations within the roll. This is important in terms of organaleptic evaluation of meat, recommendations for temperatures of cooking, and for placement of the temperature recording instrument within the meat. The range in average end point temperatures as recorded by thermocouples in positions No. 1 through No. 5 at different points within the same roll is given in Table 16.

Table 16. Range in average final internal temperature

Oven Temp.	Light meat rolls		Dark meat rolls	
	Range	Average	Range	Average
°F.	°F.	°F.	°F.	°F.
250	175 to 191	183	188 to 200	194
300	185 to 191	186	186 to 201	194
350	177 to 191	184	183 to 206	192

Figure 9. Comparison of rise in temperature for light meat and dark meat rolls roasted at three oven temperatures


200
150
100
50
0
DEGREES F.
350°
300°
250°
LIGHT MEAT ROLLS
60
120
180
240
300
360
200
150
100
50
350°
300°
250°
DARK MEAT ROLLS
60
120
180
240
TIME-MINUTES

With the variations in temperatures at the end of cooking time (Tables 12 and 13), it is obvious that there was variation in the degree of doneness within a single slice of meat.

Cooking time

An examination of the data given in Appendix A, Tables 39 and 40 and summarized in Table 17 reveals that as the oven temperature was increased for either light meat or dark meat rolls, the cooking time expressed in minutes per pound decreased. However, as illustrated graphically in Figure 10a, the decrease in cooking time in minutes per pound was greater when the oven temperature was increased from 250 to 300°F. than it was when the increase was from 300 to 350°F.

Table 17. Average minutes per pound cooking time for turkey rolls

Oven temp.	Light meat rolls			Dark meat rolls		
	End point	Raw weight	Cooking time	End point	Raw weight	Cooking time
°F.	°F.	lbs.	min./lb.	°F.	lbs.	min./lb.
250	176	6.3	51.3	185	2.7	84.0
	185	6.5	52.8	194	2.8	88.7
300	176	6.8	35.2	185	2.8	55.9
	185	6.4	37.3	194	2.8	60.5
350	176	6.4	31.1	185	3.0	45.8
	185	6.2	31.6	194	2.8	50.0

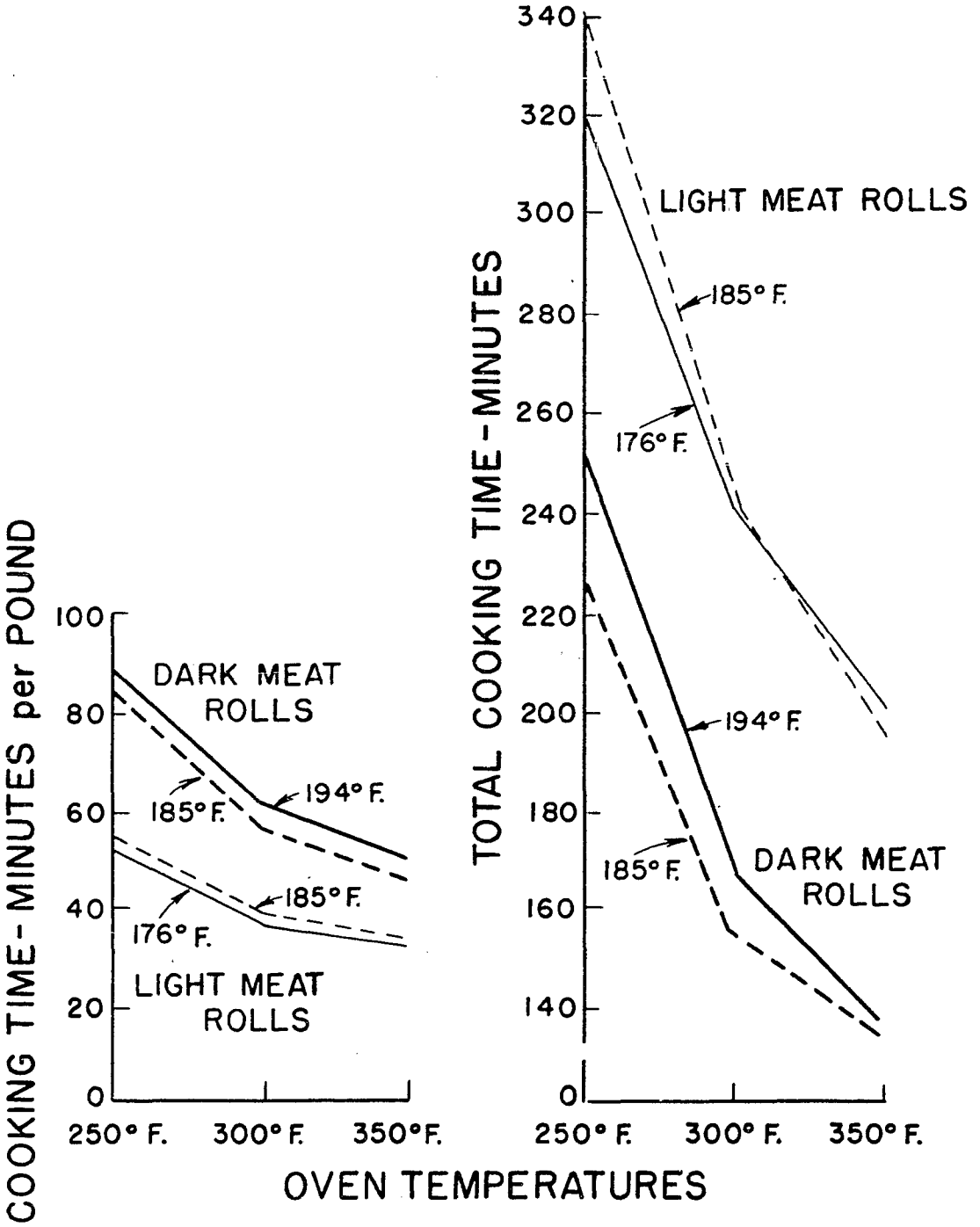
An analysis of variance revealed that (Appendix B, Table 51) there was a highly significant difference at the 1 percent level in minutes per pound cooking time as affected by oven temperatures for both light meat and dark meat rolls.

Both the linear and the quadratic effects of the oven temperature showed highly significant differences which indicated that the relationship between oven temperature and cooking time cannot be expressed by a simple linear regression equation but curves significantly so that quadratic equations would be needed for its presentation and extrapolation. This may indicate also that a further increase in oven temperature may decrease the cooking time only slightly.

In a comparison of the data on minutes per pound cooking time of light meat rolls graphed in Figure 10a, it can be seen that the minutes per pound are similar for both internal temperatures at any one oven temperature. An analysis of variance revealed that for light meat rolls roasted at each oven temperature the differences between internal temperatures at the two end points were not significant for the light meat rolls; however, for dark meat rolls the difference in minutes per pound was significant. Thus, for light meat rolls that weighed approximately 6.4 pounds, the degree of doneness did not have a significant effect on the minutes per pound cooking time required. On the other hand, for dark meat rolls that weighed 2.8 pounds there was a small but highly significant effect at the 1 percent level of the degree of doneness on the minutes per pound cooking time regardless of

Figure 10a. Cooking time in minutes per pound for light meat and dark meat rolls

Figure 10b. Total cooking time for light meat and dark meat rolls


COOKING TIME - MINUTES per POUND
100
80
60
40
20
0
DARK MEAT ROLLS
194° F.
185° F.
185° F.
176° F.
LIGHT MEAT ROLLS
250° F.
300° F.
350° F.
TOTAL COOKING TIME - MINUTES
340
320
300
280
260
240
220
200
180
160
140
0
LIGHT MEAT ROLLS
185° F.
176° F.
194° F.
185° F.
DARK MEAT ROLLS
250° F.
300° F.
350° F.
OVEN TEMPERATURES

the oven temperature.

At each of the three oven temperatures, the dark meat rolls (2.8 pounds) required a longer cooking time in minutes per pound than did light meat rolls (6.4 pounds) even when both were roasted to the same internal temperature of 185°F. (Table 17). This increase in minutes per pound cooking time as the weight decreases is typical for all meats. A direct comparison of the minutes per pound cooking time for light meat rolls versus dark meat rolls was difficult since light meat rolls and dark meat rolls varied in weight, in the degree of doneness (176 and 194°F.), and in type of meat. If a study were planned in which light meat and dark meat rolls were to be of similar weight and size, then other variables, such as cutting breast muscles to reduce the size of light meat rolls or adding dark meat from other birds to increase the size of dark meat rolls, would be introduced.

Findings in this study on the influence of size and weight on cooking time are further illustrated in a report from Brisbane (1958). She reported an average cooking time of 31.6 minutes per pound for light meat rolls roasted at 300°F. Light meat rolls in her study averaged 7.0 pounds and were dry roasted to 185°F. This 31.6 minutes per pound cooking time compares favorably with the 37.5 reported in this experiment since the light meat rolls in her study were

.6 pound heavier than those roasted in this study.

The heavy dark meat rolls used by Brisbane (1958), which included leg, thigh, and back meat and averaged 4.3 pounds, were dry roasted at 300°F. and required 42.6 minutes per pound to reach an internal temperature of 194°F. In this investigation differences in size of oven as well as roll size (4.3 pounds versus 2.8 pounds for dark meat and 7.0 pounds versus 6.4 pounds for light meat) may account for the differences in cooking time. Brisbane used an institution type oven while in this investigation the household type oven and research oven were used. In this study, the minutes per pound cooking time for dark meat rolls was 60.5 which was 18 minutes per pound longer than for those dry roasted to 194°F. at 300°F. by Brisbane (42.6).

Data on total cooking time for light meat and dark meat rolls are illustrated in Figure 10b. Oven temperatures affected cooking time more than did internal temperatures. Also, there was greater difference in the total cooking time between oven temperatures 250 and 350°F. than there was between 300 and 350°F. However, it should be noted (Figure 10b) that for light meat and dark meat rolls the greatest variation in total cooking time, 27 and 25 minutes respectively, occurred when rolls were roasted at 250°F. There was practically no variation in total cooking time for the

two end points for light meat rolls roasted at 300 and 350°F., whereas for dark meat rolls there was a small variation at 300°F. but almost no variation at 350°F.

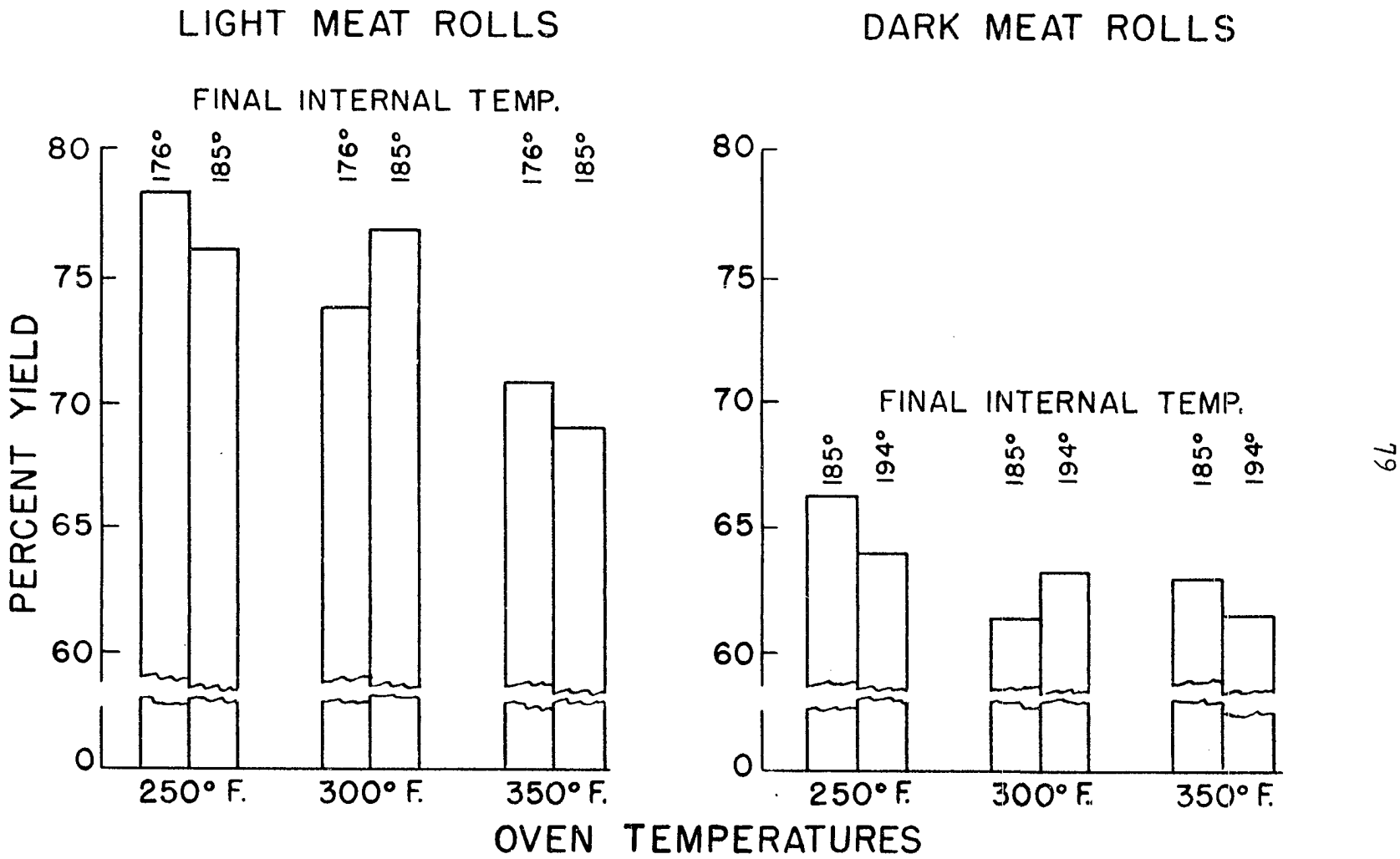
In summary, under the conditions of this study it was found that oven temperature affected both the total cooking time and the minutes per pound cooking time more than any of the other factors considered. When the weight was approximately the same for any one type of meat, and when the end point was increased 9°F., only dark meat rolls showed a slight increase in cooking time. Light meat rolls that weighed 6.4 pounds required less minutes per pound cooking time than dark meat rolls that weighed 2.8 pounds.

Yields of cooked meat

Yields for individual rolls may be found in Appendix A, Tables 32 and 33. Average yields of the rolls summarized in Table 18 were based on the weights of the ready-to-cook rolls which included edible meat and skin.

Data summarized in Table 18 reveal that, in general, as the oven temperature increased, the percent yield for both light meat and for dark meat rolls decreased. Although it appears graphically in Figure 11 that there were two exceptions to this general trend, statistical analyses reveal that there was an increase in percent yield only for light meat rolls cooked to 185°F. when oven temperatures were increased

Figure 11. Yields for light meat and dark meat rolls


LIGHT MEAT ROLLS
DARK MEAT ROLLS
FINAL INTERNAL TEMP.
176°
185°
194°
PERCENT YIELD
80
75
70
65
60
0
250° F.
300° F.
350° F.
OVEN TEMPERATURES

from 250 to 300°F.

Table 18. Average yields of cooked turkey rolls based on weights of raw turkey rolls[a]

Oven temp.	Light meat			Dark meat		
	End point	Cooked		End point	Cooked	
°F.	°F.	lbs.	%	°F.	lbs.	%
250	176	4.90	78.3	185	1.77	66.1
	185	4.96	76.1	194	1.80	63.8
300	176	4.98	73.7	185	1.70	61.1
	185	4.92	76.7	194	1.74	63.0
350	176	4.50	70.7	185	1.84	62.5
	185	4.26	68.9	194	1.69	61.2

[a]Average raw weight = 6.4 pounds for light meat rolls and 2.8 pounds for dark meat rolls

As determined by an analysis of variance, the linear effect of the oven temperatures on yields was highly significant at the 1 percent level for light meat rolls, whereas the quadratic effect was not significant. (Appendix B, Table 52). There were no significant differences in the yields of dark meat rolls.

Cooking losses

Large weight losses are very undesirable because of the costs involved and the smaller number of servings from cooked meat. It can be expected that there will be a negative correlation between total cooking losses and percent yield. Total

losses divided into their component parts, drip and volatile, may not have the same relationship. Average losses for light meat and dark meat rolls are summarized in Table 19; losses for individual rolls are given in Appendix A, Tables 41 and 42. It can be concluded from the data in Table 19 that, in general, total cooking losses increased for light meat and dark meat rolls as the oven temperatures increased.

Table 19. Average cooking losses for light meat and dark rolls

Oven temp.	Light meat rolls				Dark meat rolls			
	End point	Losses			End point	Losses		
		Total	Drip	Volatile		Total	Drip	Volatile
°F.	°F.	%	%	%	°F.	%	%	%
250	176	21.8	11.4	10.4	185	33.9	18.8	15.1
	185	24.0	11.1	12.9	194	36.2	20.1	16.1
300	176	26.3	15.3	11.0	185	38.9	24.2	14.7
	185	23.3	12.5	10.8	194	37.0	22.0	15.0
350	176	29.3	11.1	18.2	185	37.5	19.0	18.5
	185	31.1	12.9	18.2	194	38.8	20.9	17.9

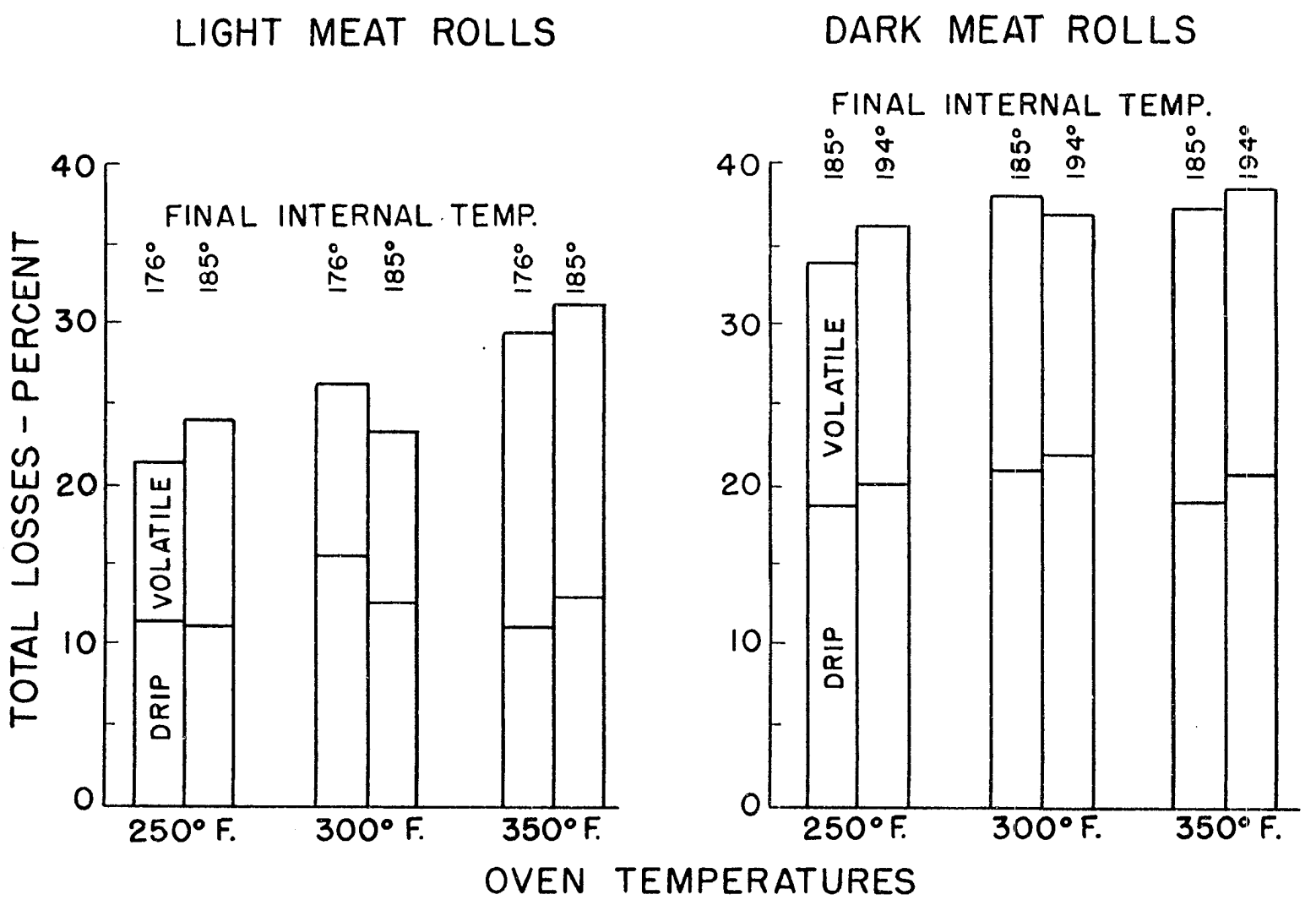
In an analysis of variance it was found that at the 1 percent level the total cooking losses for light meat rolls were linearly related to the oven temperatures. For dark meat rolls, statistical analyses revealed that there were no significant differences in total cooking losses as affected by type of oven, oven temperatures, final internal temperatures, or their interactions (Appendix B, Table 53).

Analysis of variance of the data on total cooking losses, Appendix B, Table 53, revealed that there was a significant difference at the 5 percent level in the total cooking losses of light meat rolls cooked in the Frigidaire oven versus those cooked in the Despatch oven. The average percent total losses were greater in the Frigidaire oven (26.81) than in the Despatch oven (25.06). However, since it has been shown in this investigation that oven temperature did affect yields and losses, it should be noted that when ovens were set for 350°F. the average temperature in the Frigidaire was 355°F. while in the Despatch it was 346°F. The 9°F. difference in temperature may have influenced the oven effect of the total cooking losses.

An examination of the data on drip and volatile losses for light meat rolls summarized in Table 19 indicated that, in general, drip and volatile losses were within the range of 10 to 13 percent, but volatile losses increased considerably at the highest oven temperature, 350°F. Percent drip losses for dark meat (Figure 12) may partly have been influenced by cutting the muscles necessary in the preparation of the roll or by the weight and size of the roll.

The quadratic effect of oven temperatures revealed a significant influence at the 5 percent level on drip losses of light meat rolls while there were no significant differences in drip losses of dark meat (Appendix B, Table 53).

Figure 12. Cooking losses for light meat and dark meat rolls


LIGHT MEAT ROLLS
DARK MEAT ROLLS
FINAL INTERNAL TEMP.
176°
185°
194°
TOTAL LOSSES - PERCENT
VOLATILE
DRIP
0
10
20
30
40
250° F.
300° F.
350° F.
OVEN TEMPERATURES

Analysis of variance of data on volatile losses of light meat rolls revealed significant influence of oven temperatures. The linear effect was found to be highly significant at the 1 percent level but the quadratic effect showed significant differences only at the 5 percent level. Oven temperatures did not affect significantly the volatile losses of dark meat rolls as revealed by the analysis of variance (Appendix B, Table 53).

There was no significant difference in the total cooking losses for light meat and dark meat rolls as influenced by the degree of doneness. Percent drip losses and volatile losses were similar at all end points (Figure 12) and the degree of doneness did not affect significantly the percent of drip losses or the percent volatile losses. The analyses of variance showed that there were no significant differences in drip or volatile losses when the end points were increased. Data in Appendix B, Table 53, reveals, however, that at the 5 percent level the differences in total cooking losses were significant because of the interaction between oven temperatures and final end points of the rolls.

In reviewing the data for cooking losses of the 24 light meat rolls, it should be noted that in consideration of the influence of oven temperature on the total losses only the linear effect was significant, whereas for both constituents

of total losses, drip and volatile, it was the quadratic effect of oven temperature that was significant. The linear relationship between oven temperatures and total cooking losses was, therefore, the result of the interaction of the amount of drip and volatile losses. As may be seen in Table 20, average percent drip losses for light meat rolls were highest at 300°F. and lowest at 250°F., whereas average percent volatile losses were lowest at 300°F. and highest at 350°F. while total percent losses increased as the oven temperature increased.

Table 20. Average cooking losses for light meat rolls

Oven temperature	Volatile	Drip	Total
°F.	%	%	%
250	11.55	11.24	22.79
300	10.87	14.96	25.83
350	18.22	11.97	30.19

Explanations for these data may be that at oven temperature 300°F. there was such a great reduction in cooking time for rolls cooked at 300°F. over those cooked at 250°F. that there was comparatively less evaporation although the oven temperature was higher. At 350°F. total losses were greater than at 300°F. but the cooking time was only slightly shorter and a greater percent of drip evaporated due to the higher temperature. Some of the volatile losses may be due

to drying of the roll, but subsequent evaluation of juiciness did not reveal any significant differences among rolls.

Percent total cooking losses for rolls cooked at 300°F. to the higher internal temperature, 23.3 for light meat and 37.0 for dark meat, were considerably smaller than those reported for dry roasted rolls by Brisbane (1958). Differences in percent losses may be due to differences in type of ovens used and size of the rolls. She reported total percent losses for light meat rolls of 30.5 and for dark meat rolls, 37.7.

Subjective evaluation

Two of the major concerns of prospective users of deboned light meat and dark meat turkey rolls are the maintenance of natural turkey flavor and a desirable degree of doneness. With these in mind, aroma, flavor, tenderness, juiciness, and degree of doneness were evaluated separately by a panel of seven judges. Observations regarding appearance were made on color of meat and juice by the investigator.

According to the experimental plan, judges were given slices from various sections of the roll as shown in Table 21. From an examination of the data recorded for temperature in Tables 12 and 13, it was evident there was considerable temperature variation within a single slice of meat. It could be

Table 21. Location of samples from rolls given to judges

Judge	Oven temperature											
	250°F.				300°F.				350°F.			
	Frigidaire		Despatch		Frigidaire		Despatch		Frigidaire		Despatch	
	Slice	No.	Slice	No.	Slice	No.	Slice	No.	Slice	No.	Slice	No.
A	5	7	8	5	1	4	4	9	2	6	3	10
B	4	6	9	3	7	2	3	6	1	5	8	1
C	1	3	4	2	4	6	8	7	6	1	5	9
D	8	2	2	10	3	1	7	4	5	7	9	6
E	2	4	3	7	5	8	1	10	7	2	6	5
F	3	5	1	4	6	7	2	1	9	3	7	8
G	7	8	5	9	2	3	6	2	3	4	1	4

expected that there might be variation in the degree of doneness throughout the roll as great as or greater than that within a single slice. This variation in degree of doneness also may indicate variation in other factors. For this reason panel members received slices from different locations to judge for the palatability factors and degree of doneness to give some estimation of the variation, if any, within the roll (Table 21).

Samples from light meat and dark meat rolls from which the skin had been removed were judged for aroma, flavor, tenderness, juiciness, and degree of doneness. (Appendix A, Figure 22). Each of the factors was scored from zero to ten with the exception of degree of doneness in which case judges were asked to indicate their evaluation of the degree of doneness by checking underdone, done, or overdone. As can be seen in Table 21, judges inserted two additional factors, underdone to done and done to overdone. Each judge developed his own standards during preliminary training. Data for palatability scores for individual judges and replications are given in Appendix A, Tables 43, 44, 45, and 46.

Most of the panel members were fairly consistent in their judgments of rolls receiving similar treatments. Average scores for individual judges may be seen in Appendix A,

Tables 43 and 44. In general, the judges could be categorized into high or low scorers. From the data in Appendix A, Tables 43 and 44 it can be seen that two judges (C and G) were consistently low scorers particularly for flavor and aroma, while one judge (F) showed more variation than any of the other panel members. In most instances, flavor scores were similar for all judges. Inasmuch as aroma cannot be divorced from flavor this was one of the main reasons that samples were served hot immediately after slicing, approximately 15 minutes after removal from oven. Samples were presented in a manner similar to that suggested by Dawson et al. (1958).

Appearance. There was no appreciable difference in the appearance of light meat or dark meat rolls cooked to their predetermined end points at the three oven temperatures. The drip, however, from dark meat rolls contained a great deal of sediment and was darker and more cloudy than drip from light meat. Also, at higher oven temperatures, the color of the drip was quite brown while at 250°F. it was a light amber.

Aroma, flavor, tenderness, and juiciness. Average scores for aroma, flavor, tenderness, and juiciness are presented in Table 22. Analyses of variance revealed that there were no significant differences in aroma, tenderness, or juiciness of light meat and dark meat rolls as shown in Appendix B, Table 54, and graphically in Figures 13 and 14. This was true,

also, for flavor of dark meat roll; however, the linear effect of oven temperatures showed that there was a significant difference at the 5 percent level in the flavor of light meat rolls. The flavor of rolls cooked at the lower oven temperatures was more intense than those cooked at the higher oven temperatures, Table 22. No prominent off-odors were noticed by any panel member. This was in keeping with findings of Brisbane (1958) who reported no off-odors for turkey rolls in her study.

Table 22. Average scores for aroma, flavor, tenderness, and juiciness for turkey rolls

End point	Oven temperature	Aroma	Flavor	Tenderness	Juiciness
°F.	°F.	Av.	Av.	Av.	Av.
		Light meat rolls			
178	250	5.3	5.7	7.3	6.6
	300	5.0	5.4	7.5	6.1
	350	5.0	5.0	6.9	6.2
185	250	4.8	5.5	8.2	7.0
	300	4.8	5.6	7.7	6.9
	350	5.1	5.2	7.4	5.7
		Dark meat rolls			
185	250	5.1	6.2	6.7	7.4
	300	5.0	5.7	7.0	7.5
	350	5.1	6.1	7.0	7.1
194	250	5.4	6.4	8.1	8.1
	300	5.1	6.1	7.2	7.1
	350	4.9	6.0	7.4	7.4

In a comparison of data (Table 22) for light meat and dark meat cooked to the same end point, 185°F., in general, dark meat scores averaged higher for aroma, flavor, and juiciness while light meat scored higher for tenderness.

Figure 13. Judges' mean scores for light meat rolls for aroma, flavor, tenderness, and juiciness

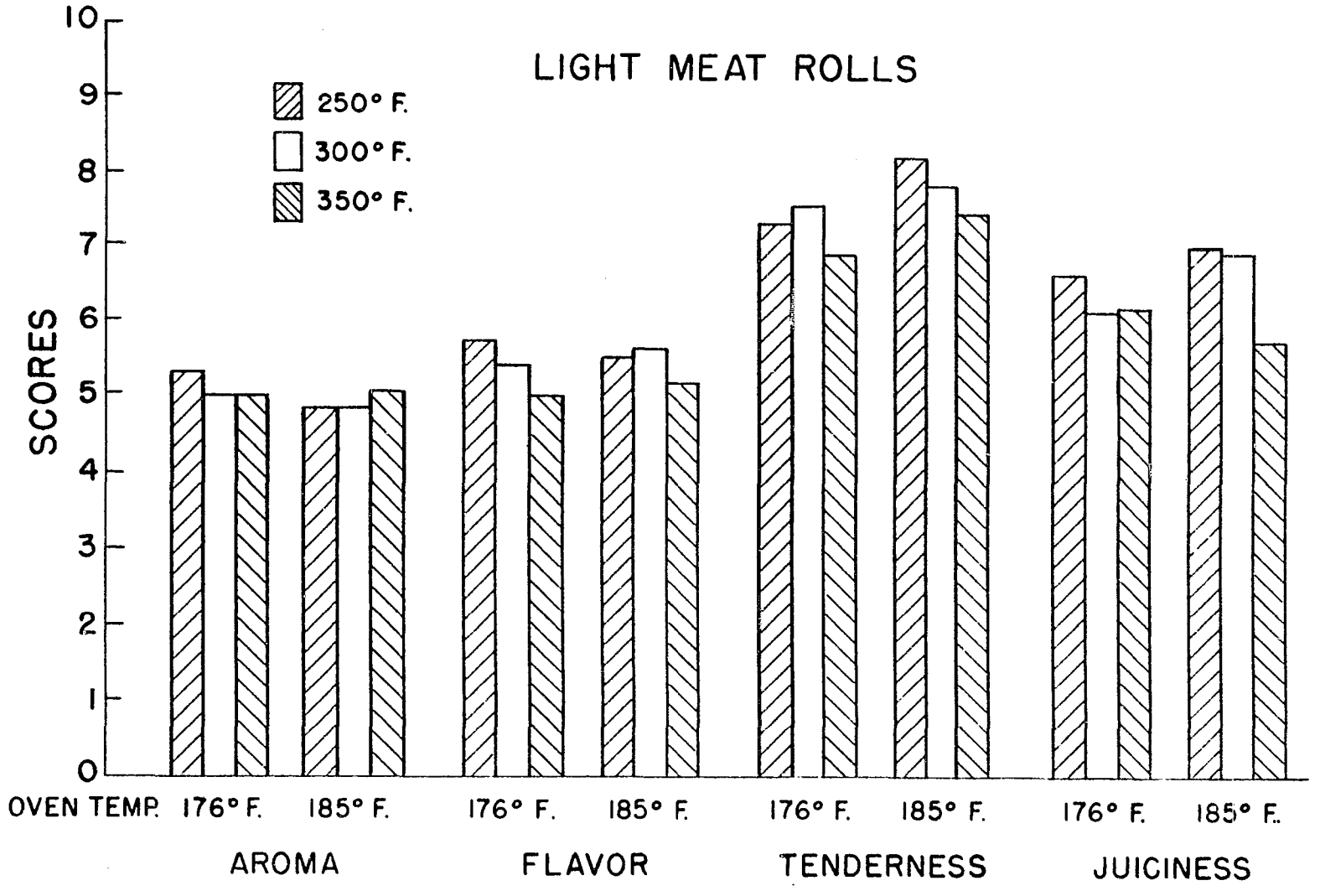
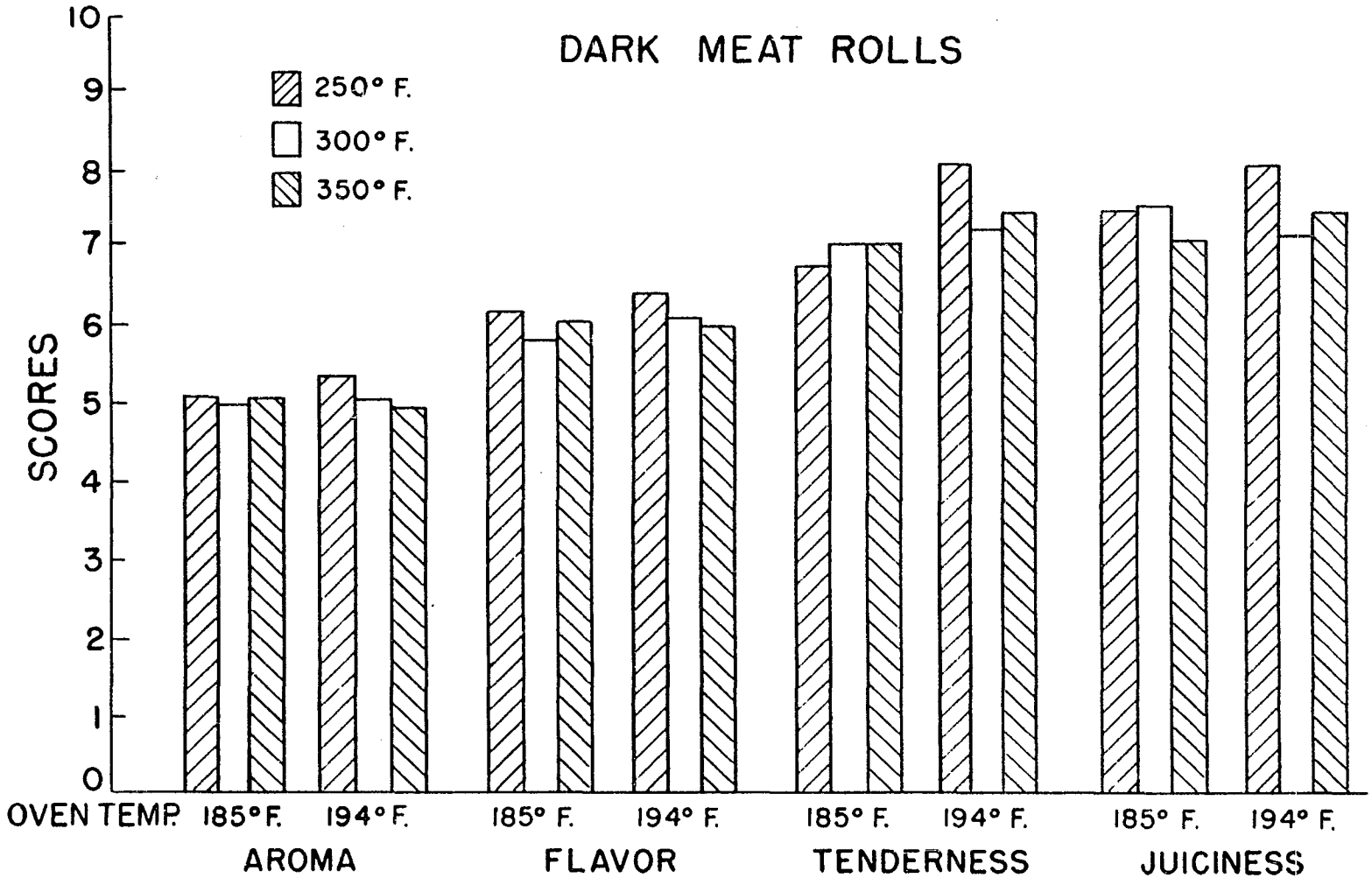

LIGHT MEAT ROLLS
250° F.
300° F.
350° F.
SCORES
10
9
8
7
6
5
4
3
2
1
0
OVEN TEMP.
176° F.
185° F.
176° F.
185° F.
176° F.
185° F.
176° F.
185° F.
AROMA
FLAVOR
TENDERNESS
JUICINESS

Figure 14. Judges' mean scores for dark meat rolls for aroma, flavor, tenderness, and juiciness


DARK MEAT ROLLS
250° F.
300° F.
350° F.
SCORES
10
9
8
7
6
5
4
3
2
1
0
OVEN TEMP.
185° F.
194° F.
185° F.
194° F.
185° F.
194° F.
185° F.
194° F.
AROMA
FLAVOR
TENDERNESS
JUICINESS

This is in agreement with findings of Cooley (1956), Schlosser et al. (1957), Ferguson (1957) and Brisbane (1958) but contrary to the findings of Crowe (1957) and Marsden et al. (1957a).

The differences in scores between light meat and dark meat may be due partly to the differences in the fat content in the light and dark muscles. It may be seen from Table 1 that there is a difference in the percent fat found in light meat and dark meat. Lowe (1955) reported that the amount and distribution of fat affect flavor of both fresh and frozen roasted poultry. The finish and fat distribution also affect juiciness.

Degree of doneness. According to Sweetman and MacKellar (1956), degree of doneness in tender meat is judged largely by the amount of external browning, development of tenderness, flavor, and aroma, internal coagulation of fibers, and change of color. Judges in this investigation were in agreement that light meat and dark meat were most underdone when cooked at the lowest oven temperature to the lower end points.

Total number of judgments for degree of doneness are presented in Table 23.

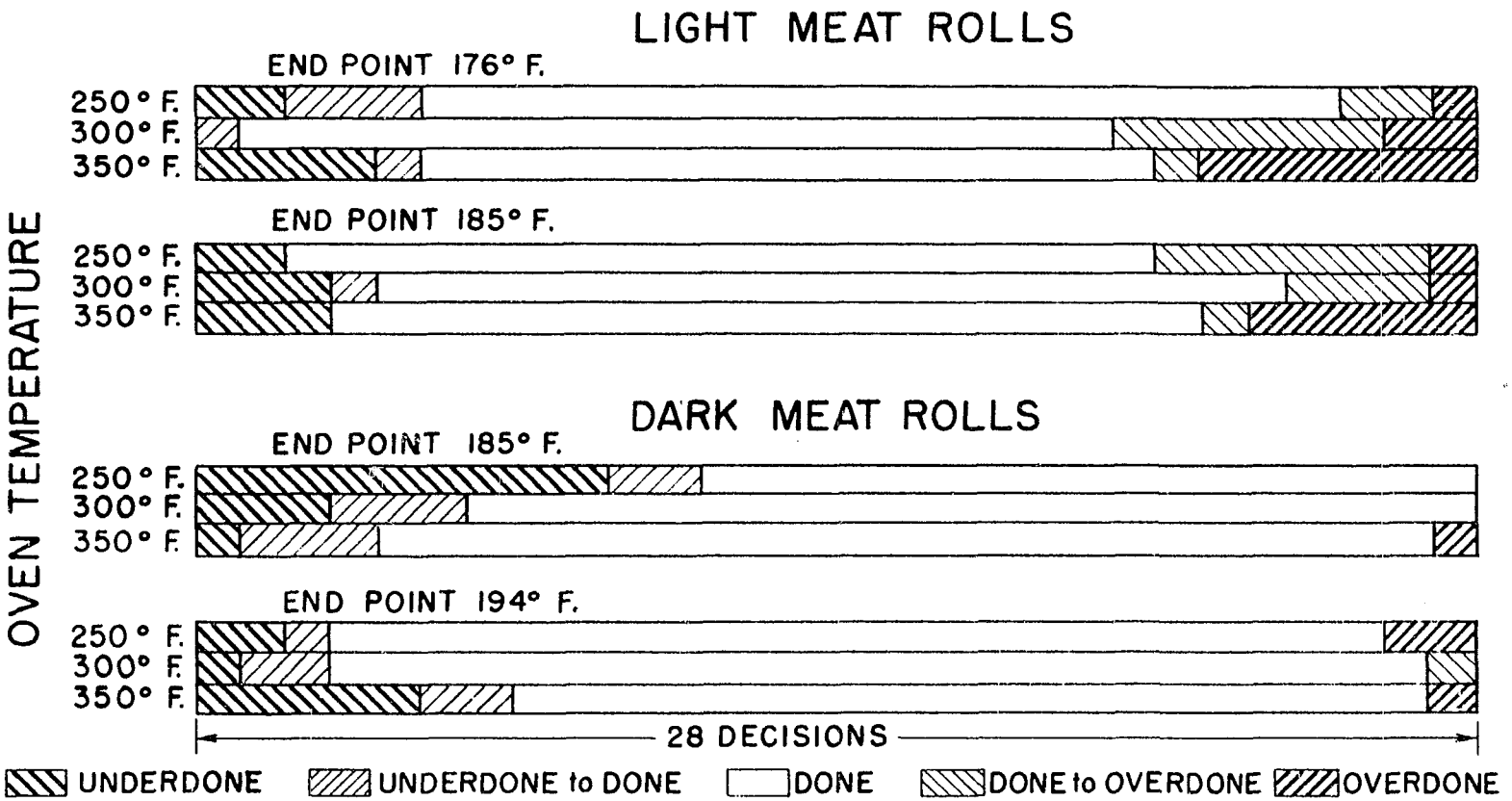
From the data in Table 23 it can be seen that light meat was judged overdone more often than was dark meat. In 168 decisions made on doneness, only five times was dark

meat judged overdone; four of these were made for meat cooked to the higher end point. On the other hand, light meat was judged overdone 34 times with decisions equally divided for rolls cooked to 176 and 185°F. Generally light meat and dark meat rolls were scored similarly for degree of doneness irrespective of the treatments, as illustrated in Figure 15.

Table 23. Summary of judges' opinions for degree of doneness for light meat and for dark meat rolls

	End point 176°F.			End point 185°F.		
Oven temp.	250°F.	300°F.	350°F.	250°F.	300°F.	350°F.
		Light meat rolls				
Underdone	2	0	4	2	3	3
Underdone to done	3	1	1	0	1	0
Done	20	19	17	19	20	19
Done to overdone	1	2	1	1	1	1
Overdone	2	6	5	6	3	5
		Dark meat rolls				
	End point 185°F.			End point 194°F.		
Underdone	9	3	1	2	1	5
Underdone to done	2	3	3	1	2	2
Done	17	22	23	23	24	20
Done to overdone	0	0	0	0	1	0
Overdone	0	0	1	2	0	1

Figure 15. Degree of doneness for light meat and dark meat rolls


LIGHT MEAT ROLLS
END POINT 176° F.
250° F.
300° F.
350° F.
END POINT 185° F.
250° F.
300° F.
350° F.
OVEN TEMPERATURE
DARK MEAT ROLLS
END POINT 185° F.
250° F.
300° F.
350° F.
END POINT 194° F.
250° F.
300° F.
350° F.
28 DECISIONS
UNDERDONE
UNDERDONE to DONE
DONE
DONE to OVERDONE
OVERDONE

For a satisfactory degree of doneness, the findings of this study would be in keeping with temperatures used by Lowe et al. (1953) of 190°F. in thigh, National Turkey Federation (Turkey Handbook ca. 1954c) of 190°F. in thigh, Cooley (1956) of 194°F. in thigh or pectoralis major, Crowe (1957) of 194°F. in thigh, and Brisbane (1958) of 185°F. in light meat rolls and 194°F. in dark meat rolls.

Objective measurement

The Warner-Bratzler shearing apparatus was used in the objective measurement of light meat; however, the results obtained by mechanical means do not correspond closely to the subjective scoring by judges. To date no method has been devised to assess all of the different factors involved in the subjective evaluation of food.

Shear force measurements obtained from 12 light meat rolls and the respective tenderness scores of the rolls are given in Appendix B, Table 55. Average tenderness scores and shear values for the samples are presented in Table 24.

Table 24. Average tenderness scores and shear force values for light meat rolls

	Oven temperature		
	250°F.	300°F.	350°F.
Tenderness scores			
End point 176°F.	7.3	7.5	6.9
185°F.	8.2	7.7	7.4
Shear force values			
End point 176°F.	2.9	3.6	2.8
185°F.	2.3	2.9	4.5

Correlation between average tenderness scores and average shear values was non significant, r = -.458, 10 d.f., Appendix B, Table 55. This is considerably lower than the correlation between shear force values and tenderness scores reported by Edgar (1953) for turkey breast muscles evaluated shortly after cooking, r =-.861 but larger than for muscles which had been frozen after cooking, and evaluated after thawing, r =-.292. Cooley (1956) reported a significant correlation, r =-.327, between the judges' scores for tenderness and the shear values of turkey meat.

Part II. Roasting Whole Turkeys and Turkey Rolls

The second part of this investigation had as its objectives to determine the difference between roasted whole turkey and turkey rolls with respect to yield and quality, and to compare the cooking time required for both to reach specified internal temperatures. It must be noted that these data are not strictly comparable because first, as far as yields are concerned, there was a variation among turkeys in the amount of light and dark meat. Second, there were weights of raw and cooked muscles used in rolls and only weights of cooked muscles for turkeys roasted whole. It is not unreasonable to suspect that the amount of cooking losses were greater in case of rolls because the muscles were cut

and, therefore, more surfaces exposed. Severing of muscles may have caused greater losses. These losses may have been counterbalanced by the longer cooking time for birds cooked whole, a state which created opportunity for more drip. Moreover, it was impossible to divide losses from whole turkeys into their components from light meat, dark meat, skin, and bone.

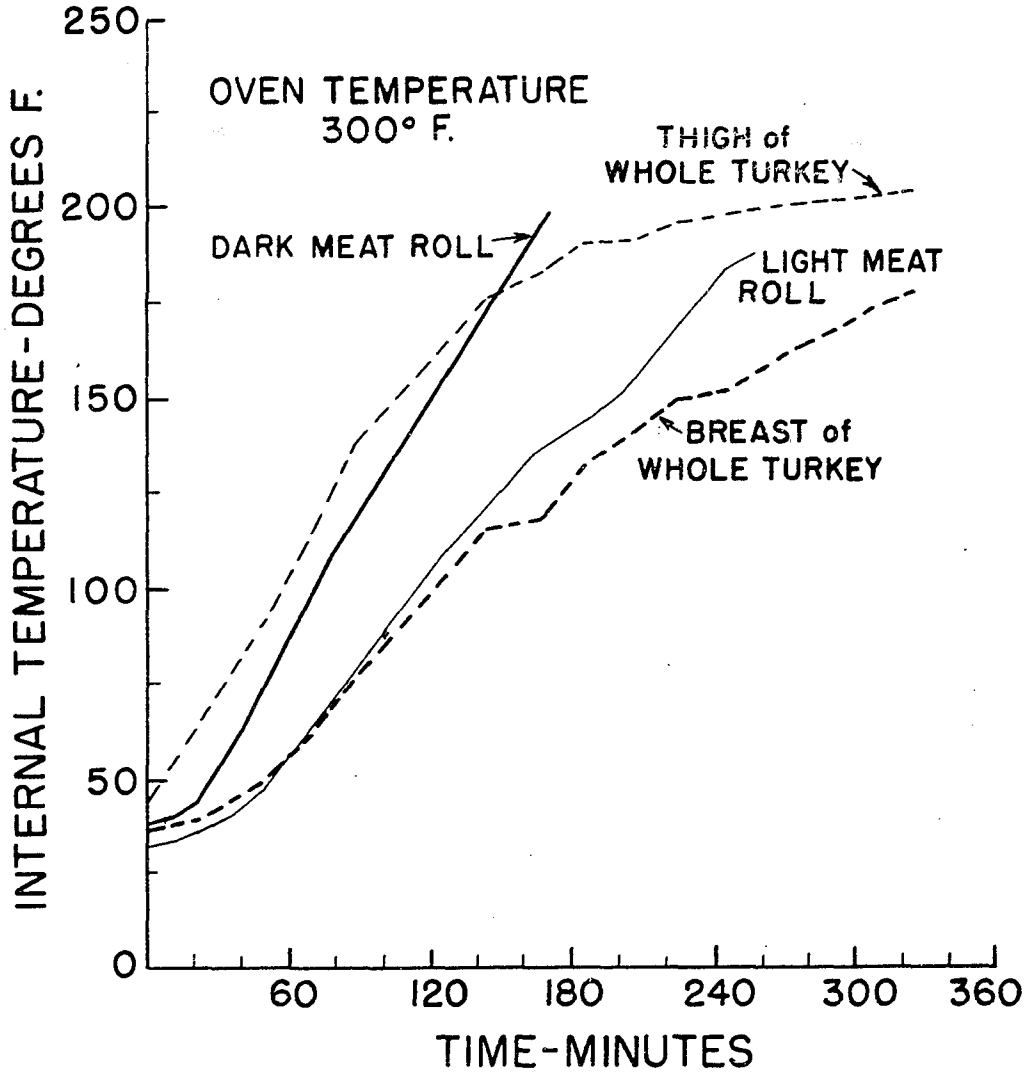
Rise in temperature

In a comparison of the rise in temperature in whole turkeys with that of turkey rolls, there was similarity between the slope of the temperature curve for breast meat of whole turkey with that of light meat rolls although for the latter there was a reduction in cooking time. The flattening of the curve for temperature in the breast of whole turkey was more pronounced than that in light meat rolls. For dark meat of both rolls and whole turkey, there was a very rapid rate of rise in temperature. It should be noted that the rise in temperature in dark meat of whole turkey was approximately 140°F. for the first half of the total cooking time, but only approximately 40°F. for the last half. The temperature curves for both rolls and whole turkey were similar for a specific type of meat. (Figure 16.)

Cooking time

The experimental plan in the second part of this investi-

Figure 16. Rise in temperature for whole turkeys *versus* rise in temperature for turkey rolls


250
200
150
100
50
0
INTERNAL TEMPERATURE-DEGREES F.
OVEN TEMPERATURE
300° F.
THIGH of
WHOLE TURKEY
DARK MEAT ROLL
LIGHT MEAT
ROLL
BREAST of
WHOLE TURKEY
60
120
180
240
300
360
TIME-MINUTES

gation provided that both whole turkeys and light meat and dark meat rolls were to be cooked at the oven temperature of 300°F. Light meat rolls were to be cooked to 176°F., but dark meat rolls and thighs of whole turkeys were to be cooked to 185°F. Two thermocouples were placed in the thickest part of the breast muscles to check the temperatures of light meat as illustrated in Figure 3a. Whole turkeys were roasted breast down on a rack in a heavy aluminum roasting pan. Cooking time, total and minutes per pound, are given in Appendix A, Table 47.

Very early in the second part of this experiment it was found that when turkeys were cooked whole, the rise in temperature was by no means as uniform as was expected. In the second bird the temperature rose much more quickly in the breast than in the thigh so that when thigh temperature was recorded as 189°F. the average temperature for the two thermocouples in the breast was already 193°F. (Table 25). This was the only bird in which breast temperatures averaged higher than did thigh. Findings in this study were in keeping with those of Crowe (1957), who reported lower average temperatures in breast muscles than in thigh for all replications except one, for dry roasted whole turkeys. In the third bird roasted whole in this study, however, the temperature in the thigh was as high as 203°F. while the average for the breasts was only 148°F. as

may be seen in Table 25. Such large variations in temperature for different muscles at a given time cannot be explained within the limits of this study, but they indicate that it is extremely difficult to obtain the most desirable degree of doneness in all parts of the bird when it is roasted whole. Even if two birds were cooked to the same temperature, as indicated by thermocouples or thermometer in the thigh muscles, temperatures in the breast muscles may vary as much as 20 to 40°F. Average end point temperatures for thigh and breast muscles are presented in Table 25.

Table 25. Average final internal temperatures for whole turkeys and turkey rolls

Replication	Whole turkey		Rolls	
	Breasts	Thighs	Light meat	Dark meat
	°F.	°F.	°F.	°F.
1	185	195	176	185
2	193	189	184	186
3	148	203	186	194
4	170	204	176	201
5	176	208	176	200
6	172	205	176	204

After such large variations in internal temperatures of the whole turkey were found, it was thought necessary to depart from the experimental plan for the rolls and to obtain rolls cooked to the same approximate degree of doneness as was the whole turkey cooked on that day. Average cooking time is summarized in Table 26.

Table 26. Average cooking time for whole turkeys and turkey rolls

	Raw weight	Cooking time	
		Total	Min./lb.
	lbs.	min.	
Whole turkeys	19.05	288	15.13
Light meat rolls	6.49	248	38.21
Dark meat rolls	2.83	183	64.66

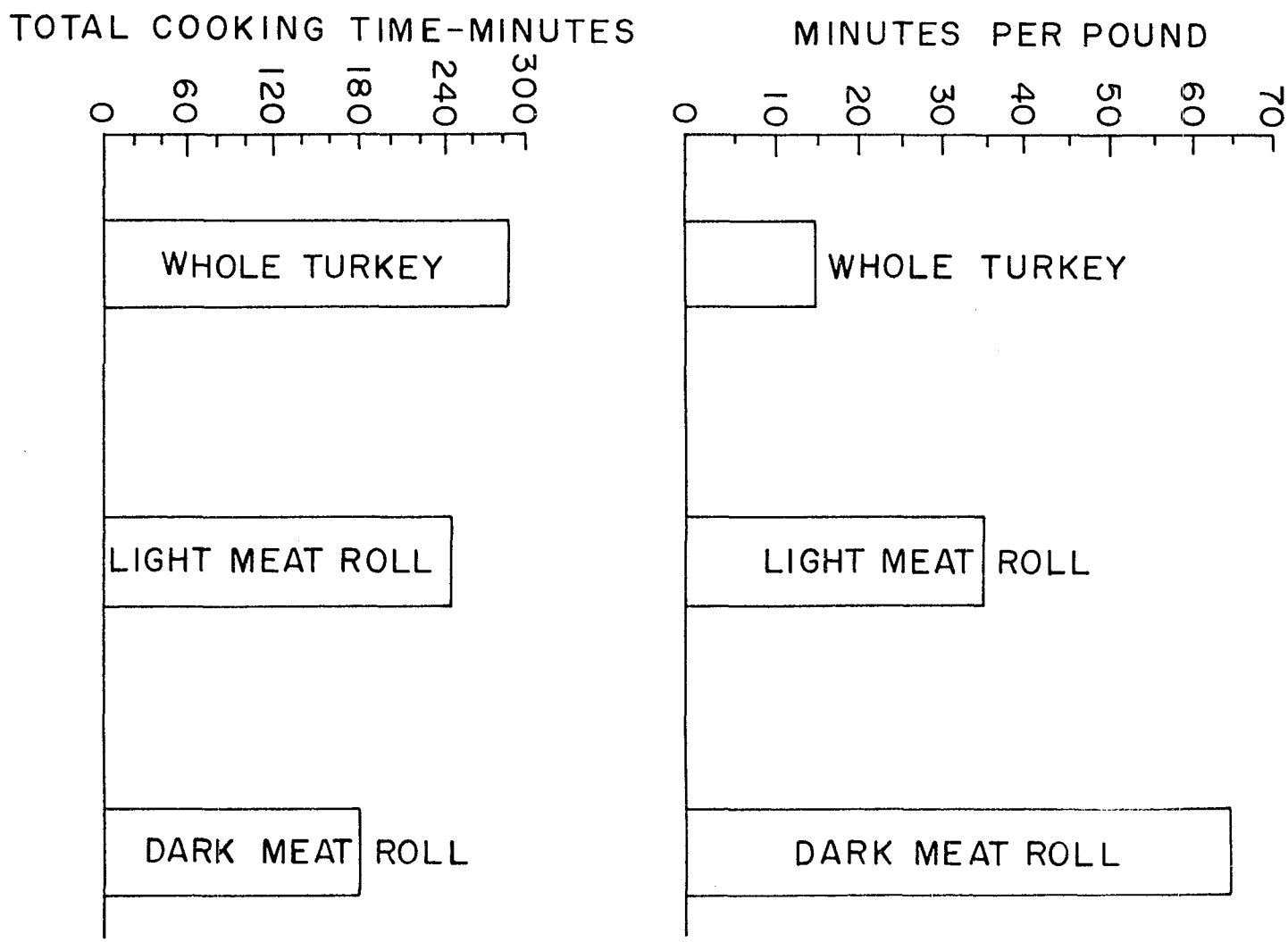
These variations in cooking time and end points were reflected in the evaluation of the degree of doneness as can be seen in the inspection of analyses of variance for the subjective data, Appendix B, Table 56.

Total cooking time for whole turkeys averaged 288 minutes which was 40 minutes longer than for light meat rolls and 105 minutes longer than that for dark meat rolls as illustrated in Figure 17. Average cooking time in minutes per pound was 15 minutes for whole turkeys which was less than one-half that of light meat rolls and about one-fourth that of dark meat rolls. As may be seen from data in Appendix A, Table 47, in an attempt to get the same degree of doneness for rolls as for turkeys cooked on the same days, the average cooking time for rolls was slightly longer than in the first part of the study.

Yields of cooked meat

Yields of cooked meat from whole turkey, breast, wings, thighs and back, and legs are presented in Appendix A, Table 34.

Figure 17. Cooking time for whole turkeys *versus* cooking time for turkey rolls


TOTAL COOKING TIME-MINUTES
0
60
120
180
240
300
WHOLE TURKEY
LIGHT MEAT ROLL
DARK MEAT ROLL
MINUTES PER POUND
0
10
20
30
40
50
60
70
WHOLE TURKEY
LIGHT MEAT ROLL
DARK MEAT ROLL

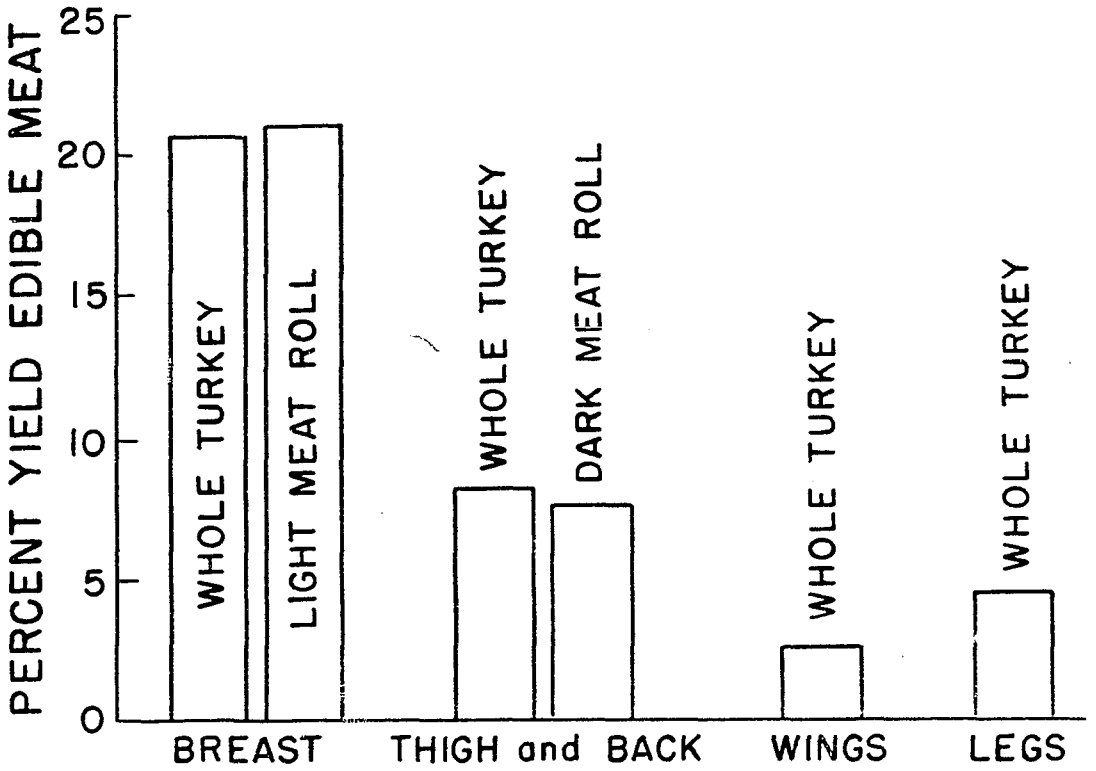
Average yield for whole cooked turkey, on the basis of ready-to-cook weights, was 72.62 percent with a range of from 77.54 to 68.07. These results are within range of data reported in the Turkey Handbook (ca. 1954c) and almost the same as data of Pecot and Watt (1956) in their report for U.S.D.A. On the basis of the weight of the ready-to-cook bird, thawed without giblets and neck, the average percent yield of cooked edible meat for whole turkeys and rolls is shown in Table 27.

Table 27. Average percent yields of cooked edible meat from whole turkey and turkey rolls

	Whole turkey	Turkey rolls
	%	%
Breast	20.51	20.93
Thighs and back	8.10	7.69
Wings	2.55	----
Legs	4.54	----

Total edible meat for whole turkey was found to be 35.7 percent. This agrees with findings of Crowe (1957), who reported a total of 35 percent for sliced light and dark meat and in addition 4 percent edible trim which was not accounted for in this study. When yields of light meat and dark meat from whole turkeys and corresponding rolls were compared as illustrated graphically in Figure 18, it was seen that there was less than one percent difference in the yields of breast, or thigh and back meat, from whole turkeys and turkey

Figure 18. Yield for whole turkeys *versus* yield for turkey rolls


PERCENT YIELD EDIBLE MEAT
25
20
15
10
5
0
WHOLE TURKEY
LIGHT MEAT ROLL
WHOLE TURKEY
DARK MEAT ROLL
WHOLE TURKEY
WHOLE TURKEY
BREAST
THIGH and BACK
WINGS
LEGS

rolls. These small variations may have been due partly to the individuality of the birds.

Cooking losses

Cooking losses for whole birds and rolls are presented in Appendix A, Table 48. As explained above, losses cannot be strictly compared. The average percent losses for whole birds cannot be compared with losses from light meat and dark meat rolls; however, they are presented in Table 28.

Table 28. Average percent cooking losses for whole turkeys and turkey rolls

	Total losses		Drip	Volatile
	lbs.	%	%	%
Whole turkeys	5.2	27.38	15.21	12.17
Light meat rolls	1.8	27.39	14.72	12.67
Dark meat rolls	1.1	37.76	24.47	13.29

Total losses for light meat and dark meat rolls were slightly higher than for comparable losses in the first part of the study, 1 and 0.7 percent respectively. This increase in cooking losses may be due to increased cooking time which was mentioned above.

Subjective evaluation

Samples from whole roasted turkey and turkey rolls were scored for aroma, flavor, tenderness, juiciness, and degree

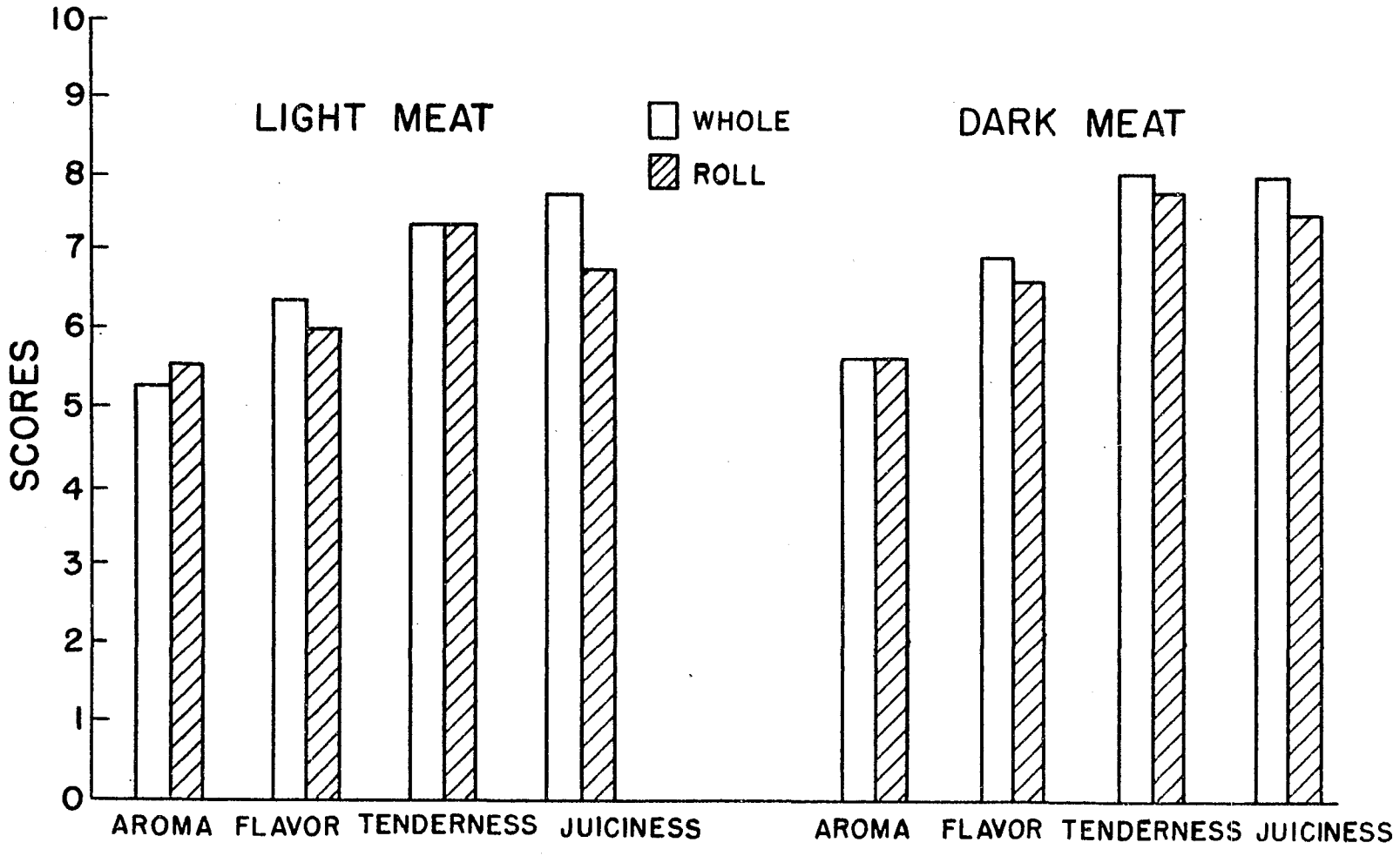
of doneness, using the same score card as was used in the first part of this investigation. Light meat samples from both whole turkey and turkey rolls were machine sliced, but because of the difficulty in handling dark meat from the whole bird, dark meat samples were hand sliced. For the evaluation of the samples, judges were given slices from the same location of the muscle for the whole turkey and for the rolls.

According to analyses of variance as shown in Appendix B, Table 56, there were no significant differences in aroma, flavor, tenderness, or juiciness of light and dark meat from whole turkey or turkey rolls. Average judges' scores for aroma, flavor, tenderness, and juiciness are presented in Appendix A, Tables 49 and 50. Average scores for aroma, flavor, tenderness, and juiciness for whole turkeys and turkey rolls are summarized in Table 29, and shown graphically in Figure 19.

Table 29. Average judges' scores for aroma, flavor, tenderness, and juiciness for whole turkeys *versus* turkey rolls

	Light meat		Dark meat	
	Whole turkey	Roll	Whole turkey	Roll
Aroma	5.2	5.5	5.6	5.6
Flavor	6.3	6.0	6.9	6.6
Tenderness	7.3	7.3	8.1	7.8
Juiciness	7.7	6.7	8.0	7.5

Figure 19. Judges' mean scores for aroma, flavor, tenderness, and juiciness


10
9
8
7
6
5
4
3
2
1
0
SCORES
LIGHT MEAT
WHOLE
ROLL
DARK MEAT
AROMA
FLAVOR
TENDERNESS
JUICINESS
AROMA
FLAVOR
TENDERNESS
JUICINESS

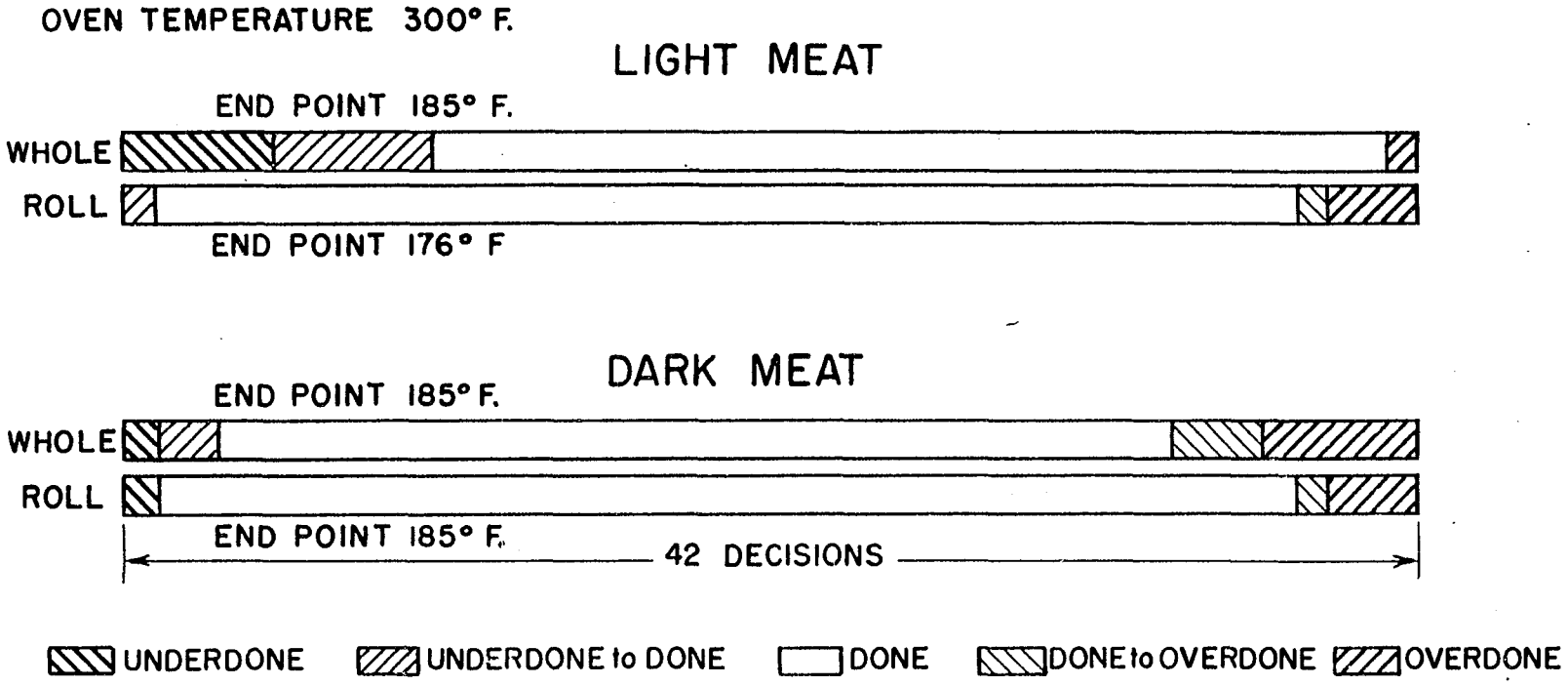
According to statistical analysis for the judges' scores, there was no real difference in the quality factors evaluated between roasted whole turkey and light meat and dark meat rolls. This would be in keeping with the report from Botsford (1950), who suggested that turkey rolls had the advantage of the rich flavor of turkey with tender succulent meat without the bulk of the whole bird.

Total judgments for degree of doneness are presented in Table 30. An observation of the data shown graphically in Figure 20, reveals that, in general, judges were satisfied with doneness of the whole turkey and rolls; however, it is interesting to note that according to the opinion of judges samples from the turkey rolls were more uniformly done than the light meat and dark meat samples from turkeys roasted whole. Lesser uniformity of whole turkeys may have been influenced by the different degrees of doneness of the various birds roasted as whole turkeys.

Table 30. Summary of judges' opinions for degree of doneness for whole turkeys versus turkey rolls

	Light meat		Dark meat	
	Whole	Roll	Whole	Roll
Underdone	5	0	1	1
Underdone to done	5	1	2	0
Done	31	37	31	37
Done to overdone	0	1	3	1
Overdone	1	3	5	3

Figure 20. A comparison of degree of doneness for whole turkeys and turkey rolls


OVEN TEMPERATURE 300° F.
LIGHT MEAT
END POINT 185° F.
WHOLE
ROLL
END POINT 176° F
DARK MEAT
END POINT 185° F.
WHOLE
ROLL
END POINT 185° F.
42 DECISIONS
UNDERDONE
UNDERDONE to DONE
DONE
DONE to OVERDONE
OVERDONE

CONCLUSIONS

Under the conditions used in this study, the following conclusions may be made:

1. For light and dark meat of turkey, the rise in temperature is directly correlated with oven temperatures.

2. When light meat rolls are roasted at an oven temperature of 250°F., after the period of rapid rise in temperature, there is a decrease in the rate of rise which may be caused by protein coagulation. At oven temperatures 300 and 350°F. there is a constant increase in the rise of temperature.

3. Although the initial internal temperatures of rolls are similar, there is a difference in the rate of temperature rise within different locations of light meat and dark meat rolls. There is considerable variation in the degree of doneness for a given slice of meat; this reflects the variations in final temperatures found at different locations within the roll.

4. The cooking time, total and minutes per pound, for rolled meat varies inversely with oven temperatures.

5. There is a greater difference between the total cooking time of turkey rolls roasted at oven temperatures 250 and 300°F. than between those roasted at 300 and 350°F.

6. There is a negative correlation between percent yields and oven temperatures for cooked light meat rolls weighing 6.4

pounds. There is no significant difference in the yield of dark meat rolls weighing 2.8 pounds when roasted at the different oven temperatures.

7. Total cooking losses for light meat rolls are affected significantly by ovens, oven temperature, and interactions between these; and also by the degree of doneness; but dark meat rolls are not affected significantly by the treatments used in this study.

8. When light meat and dark meat rolls are prepared from a single turkey, either 176 or 185°F. can be used as an end point for doneness of light meat rolls and 185 or 194°F. can be used for doneness of dark meat rolls.

9. Based on the ready-to-cook weights, whole turkeys weighing 19 pounds yield 55 percent total edible sliceable meat.

10. According to the judges in this study, there is no real difference between turkeys roasted whole and those roasted as light meat and dark meat rolls as determined by the quality factors flavor, tenderness, and juiciness.

11. In the practical cooking of turkey for institution use, turkey rolls are easier to handle and slice, and the meat is more uniformly done than that in whole birds. Turkey rolls should be turned during roasting. If whole turkeys are roasted, the temperature in the breast should be used as the final internal temperature.

SUMMARY

In this study, factors affecting the quality of whole turkey and turkey rolls have been investigated. Thirty-six Grade A Broad Breasted Bronze, oven-ready tom turkeys, 20 to 22 pounds were used. In the first part of the experiment 24 birds were thawed, deboned, and shaped into light meat and dark meat rolls. Light meat rolls were dry roasted to 176 and 185°F. and dark meat rolls to 185 and 194°F. at temperatures of 250, 300, and 350°F. in either a Despatch or Frigidaire oven. In the second part of the study six birds were roasted whole and six roasted as light meat and dark meat rolls at 300°F. In both parts of the study, hot slices of light and dark meat were served to a panel of seven judges who scored samples for aroma, flavor, tenderness, juiciness, and degree of doneness.

Weight and linear measurement changes that occurred during pretreatment, storage, thawing, deboning, and final cooking were determined. Also, measurements were made of drip volumes. Statistical analyses were made to determine effects of ovens, oven temperatures, end points and their interactions on cooking time, yields, cooking losses, and quality.

There were no losses in weight during frozen storage. Thawing loss for birds thawed 72 hours was approximately 0.2 pound, whereas for those thawed 96 hours the increased loss was negligible, 0.04 pound.

On the basis of as purchased weights, the average percent raw breast muscles used was 26.5, thighs and backs, 11.4; on the basis of thawed ready-to-cook weights not including giblets and neck, the percents were 29.4 and 12.6 respectively.

There was very little variability in oven temperature at the different settings. The greatest difference between the Frigidaire and the Despatch ovens was 9°F. at 350°F.

Data were collected for the evaluation of light meat rolls weighing 6.4 pounds, and dark meat rolls weighing 2.8 pounds on cooking time, yields, and losses.

At each oven temperature, the rise of internal temperature in dark meat rolls was more rapid than in light meat rolls. A rapid rise followed a warm up period for turkey rolls. After the rapid rise, which had a direct correlation with oven temperature, there was a decline in rate of rise at oven temperature 250°F. probably indicating protein coagulation.

The cooking time for light meat and dark meat rolls was significantly influenced by oven temperatures and size of the rolls. The cooking time, total and minutes per pound, varied inversely with the oven temperature. Cooking time at 250°F. was considerably longer than at 300 and 350°F.

In general, there was a negative correlation between percent yields of cooked light meat turkey rolls and oven temperatures. As the temperatures increased, the percent yields decreased. The analysis of variance indicated that the linear effect of oven temperatures on yields of light meat rolls was highly significant while there was no significant difference in yields of dark meat rolls at the different oven temperatures.

Factors affecting the extent of the total cooking losses of light meat rolls during cooking were differences in ovens, oven temperatures, and interaction between these. There was no significant difference in total losses of dark meat rolls.

Analysis of variance indicated that there was a quadratic relationship between drip losses of light meat rolls and oven temperatures; however, in dark meat rolls, oven temperatures had no significant effect on the drip losses.

The volatile losses of light meat rolls were linearly and quadratically related to the oven temperature, but there were no significant differences in the volatile losses of dark meat rolls.

No significant differences were found in aroma, flavor, tenderness, or juiciness for dark meat rolls for any of the treatments used. On the other hand, there were significant differences found in the flavor of light meat rolls but no

significant differences for aroma, tenderness, and juiciness. At the 5 percent level, differences in flavor of light meat rolls were linearly related to oven temperatures; the flavor of the rolls cooked at 250°F. scored higher for intensity of flavor. No prominent off-odors were found.

Regardless of the treatment used, average judges' scores revealed that the degree of doneness was satisfactory; however, judges scored light meat overdone more often than they did dark meat.

There was no significant correlation between average shear force measurements and average tenderness scores for the light meat rolls tested.

In the second part of the study, it was found that cooking time in minutes per pound for light meat rolls was approximately two-thirds longer than that for whole turkey. For dark meat rolls cooking time in minutes per pound was slightly more than four times that for whole turkey.

The percent yield from breast, thigh, and back meat of whole turkeys and rolls were similar. Based on ready-to-cook weight, the percent total edible sliceable meat from whole turkey was 35.

Cooking losses of whole turkey could not be compared with losses for rolls. Because of obvious differences such

as size, shape, presence of skin and bone, and other physical characteristics, a direct comparison cannot be made. However with these differences in mind, it is of interest to note that on the basis of raw weights of whole turkey, light meat rolls, and dark meat rolls, the percent total losses were approximately the same for whole turkey and light meat rolls but were approximately 10 percent larger for dark meat rolls than either whole turkey or light meat rolls.

For rolls cooked at 300°F., total losses in second part of the study were slightly higher than for rolls cooked in the first part of the experiment. In the second part where light meat rolls were cooked one minute more per pound and dark meat rolls four minutes more per pound than in the first part of the study, the increased time may account for increased losses.

No significant differences were found between light and dark meat from whole turkeys and that from turkey rolls as determined by aroma, flavor, tenderness, and juiciness.

In the opinion of judges, samples of light meat and dark meat rolls were more uniformly done than those from whole turkeys although all samples were considered satisfactorily done.

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APPENDIX A

Table 31. Whole turkeys. Identification; thawing, deboning, and cooking dates; frozen and thawed weights with standard deviations; roll numbers

Turkey	Date removed from freezer	Date of deboning	Date of cooking	Weight				Roll	
				Frozen as purchased		Thawed without giblets and neck		light meat	dark meat
				lb.	g.	lb.	g.	No.	No.
C	4/26	4/29	4/30	21.63	9818	19.56	8893	54	55
D	4/26	4/29	4/30	20.56	9336	18.67	8476	56	57
E	4/27	4/30	5/1	20.50	9308	18.46	8381	58	59
F	4/27	4/30	5/1	21.25	9648	19.06	8653	60	61
G	4/28	5/1	5/2	21.63	9818	19.40	8806	62	63
H	4/28	5/1	5/2	20.31	9222	18.09	8216	64	65
I	5/2	5/5	5/6	21.63	9818	19.79	8983	66	67
J	5/2	5/5	5/6	20.94	9506	18.88	8571	68	69
K	5/3	5/6	5/7	21.19	9619	19.11	8674	70	71
L	5/3	5/6	5/7	21.75	9875	19.84	9009	72	73
M	5/4	5/7	5/8	21.63	9818	19.53	8864	74	75
N	5/4	5/7	5/8	21.06	9562	19.01	8634	76	77
O	5/5	5/8	5/9	21.13	9590	19.24	8735	78	79
P	5/5	5/8	5/9	21.06	9562	19.14	8690	80	81
Q	5/9	5/12	5/13	20.06	9108	17.89	8122	82	83
R	5/9	5/12	5/13	21.75	9875	19.74	8964	84	85
S	5/10	5/13	5/14	21.19	9619	19.09	8664	86	87
T	5/10	5/13	5/14	20.88	9478	18.68	8479	88	89
U	5/11	5/14	5/15	20.00	9080	17.92	8136	90	91
V	5/11	5/14	5/15	21.69	9846	19.84	9005	92	93
W	5/16	5/19	5/20	20.25	9194	18.27	8293	94	95
X	5/16	5/19	5/20	20.06	9108	17.94	8145	96	97
Y	5/17	5/20	5/21	20.06	9108	17.99	8171	98	99
Z	5/17	5/20	5/21	20.25	9194	18.21	8267	100	101
s				.62	288	.67	307		

Table 31. (Continued)

Turkey	Date removed from freezer	Date of deboning	Date of cooking	Weight				Rolls	
				Frozen as purchased		Thawed without giblets and neck		light meat	dark meat
				lb.	g.	lb.	g.	No.	No.
AC	5/24	5/27	5/28	21.88	9932	19.91	9039	102	103
AI	5/24	---	5/28	20.44	9279	18.39	8344	104	105
AJ	5/26	5/29	5/30	20.63	9364	18.50	8399	112	115
AL	5/26	---	5/30	20.13	9137	18.12	8226	114	113
AM	5/30	6/2	6/3	20.13	9137	17.98	8163	116	117
AN	5/30	---	6/3	20.44	9279	18.48	8390	118	119
AO	5/31	6/3	6/4	21.63	9818	19.40	8808	122	121
AP	5/31	---	6/4	21.94	9960	19.85	9012	120	123
AQ	6/1	6/4	6/5	21.75	9875	19.76	8971	124	127
AR	6/1	---	6/5	21.88	9932	19.96	9057	126	125
AS	6/2	6/5	6/6	21.19	9619	18.93	8594	130	131
AT	6/2	---	6/6	21.69	9846	19.52	8862	128	129
s				.73	334	.75	339		

Table 32. Weights and percent yields of raw and cooked breast muscles and light meat rolls

End point	Roll	Breast meat Raw		Breast meat Cooked			Light meat rolls Raw		Light meat rolls Cooked		
°F.	No.	lbs.	g.	lbs.	g.	%	lbs.	g.	lbs.	g.	%
					Oven Temperature 250°F.						
176	56	5.54	2516	4.46	2025	80.48	6.43	2921	4.95	2250	77.03
	80	5.55	2522	4.03	1829	72.52	6.28	2850	4.66	2114	74.18
	86	5.56	2524	4.31	1955	77.46	6.49	2947	5.07	2302	78.11
	98	5.62	2550	4.27	1937	75.96	5.84	2650	4.91	2229	84.11
Av.		5.57	2528	4.27	1936	76.60	6.26	2842	4.90	2224	78.25
185	54	5.91	2685	4.31	1959	72.96	7.02	3188	5.27	2391	75.00
	78	5.36	2434	4.10	1862	76.50	6.43	2918	4.95	2249	77.67
	88	5.31	2411	4.04	1836	75.21	6.19	2812	4.70	2136	75.90
	100	5.64	2559	4.18	1897	74.13	6.47	2938	4.93	2240	76.24
Av.		5.55	2522	4.16	1888	74.65	6.53	2964	4.96	2254	76.05
					Oven Temperature 300°F.						
176	66	5.53	2510	4.01	1821	72.55	6.77	3073	4.98	2263	73.64
	92	6.17	2801	4.45	2021	72.15	7.09	3220	5.17	2346	72.86
	58	5.50	2496	4.18	1900	76.12	6.34	2877	4.86	2209	76.78
	74	5.88	2672	4.20	1905	71.29	6.86	3114	4.92	2233	71.71
Av.		5.77	2620	4.21	1912	72.97	6.76	3071	4.98	2263	73.68
185	68	4.97	2255	3.73	1692	75.03	5.91	2682	4.40	2000	74.57
	90	5.38	2443	4.01	1820	74.50	6.12	2778	4.63	2103	75.70
	60	5.97	2710	3.85	1749	64.54	7.06	3206	5.56	2526	78.79
	76	5.61	2547	4.45	2023	79.43	6.58	2989	5.09	2312	77.35
Av.		5.48	2489	4.01	1821	73.17	6.42	2914	4.92	2235	76.71

Table 32. (Continued)

End point	Roll	Breast meat Raw		Breast meat Cooked			Light meat rolls Raw		Light meat rolls Cooked		
°F.	No.	lbs.	g.	lbs.	g.	%	lbs.	g.	lbs.	g.	%
					Oven Temperature 350°F.						
176	64	4.99	2264	3.51	1594	70.41	5.86	2661	4.19	1902	71.48
	84	6.13	2782	4.05	1841	66.17	6.91	3138	4.77	2168	69.09
	72	6.07	2754	3.62	1845	66.99	6.74	3061	4.78	2172	70.96
	94	5.29	2402	3.71	1686	70.19	5.98	2717	4.27	1940	71.40
Av.		5.62	2550	3.72	1741	68.28	6.37	2894	4.50	2045	70.68
185	62	5.60	2542	3.90	1769	69.59	6.45	2930	4.50	2045	69.80
	82	4.54	2062	2.94	1335	64.74	5.36	2434	3.64	1652	67.87
	70	5.57	2530	3.75	1802	71.22	6.76	3071	4.60	2087	67.96
	96	5.43	2467	3.73	1695	68.71	6.18	2805	4.32	1961	69.91
Av.		5.28	2400	3.58	1650	68.75	6.19	2810	4.26	1936	68.91

Table 33. Weights and percent yields of raw and cooked thigh and back muscles and dark meat rolls

End point	Roll	Thigh and back meat Raw		Cooked			Dark meat rolls Raw		Cooked		
°F.	no.	lbs.	g.	lbs.	g.	%	lbs.	g.	lbs.	g.	%
					Oven Temperature 250°F.						
185	89	2.28	1036	1.54	701	67.66	2.79	1266	1.81	824	65.09
	101	2.25	1020	1.49	677	66.37	2.57	1166	1.75	796	68.27
	57	2.27	1032	1.42	646	62.60	2.67	1214	1.70	771	63.51
	81	2.31	1051	1.58	718	68.32	2.69	1222	1.82	828	67.76
Av.		2.28	1034	1.51	685	66.23	2.68	1217	1.77	805	66.13
194	87	2.22	1007	1.47	669	66.43	2.83	1286	1.73	786	66.12
	99	2.36	1070	1.46	665	62.15	2.70	1225	1.69	768	62.69
	55	2.54	1155	1.58	717	64.30	2.98	1351	1.84	835	61.81
	79	2.35	1068	1.67	759	71.07	2.77	1256	1.93	876	69.75
Av.		2.37	1075	1.54	702	65.35	2.82	1279	1.80	816	63.80
					Oven Temperature 300°F.						
185	59	2.23	1014	1.14	518	51.08	2.64	1197	1.35	615	51.38
	77	2.34	1063	1.51	684	64.35	2.63	1194	1.74	788	66.00
	69	2.45	1114	1.70	773	69.39	3.09	1405	1.99	904	64.34
	93	2.43	1104	1.31	593	53.71	2.77	1256	1.71	778	61.94
Av.		2.36	1074	1.41	642	59.79	2.78	1263	1.70	771	61.07
194	61	2.41	1093	1.43	651	59.56	2.88	1307	1.68	765	58.53
	75	2.51	1140	1.60	725	63.60	2.72	1235	1.88	854	69.15
	67	2.45	1111	1.54	700	63.01	2.87	1303	1.81	820	62.93
	91	2.26	1026	1.37	622	60.62	2.58	1170	1.58	719	61.45
Av.		2.41	1092	1.48	674	61.74	2.76	1254	1.74	789	62.97

Table 33. (Continued)

End point	Roll	Thigh and back meat Raw		Cooked			Dark meat rolls Raw		Cooked		
°F.	No.	lbs.	g.	lbs.	g.	%	lbs.	g.	lbs.	g.	%
						Oven Temperature 350°F.					
185	85	2.75	1250	1.65	751	60.08	3.06	1389	2.06	936	67.39
	97	2.33	1059	1.40	638	60.24	2.75	1247	1.66	754	60.47
	65	2.40	1089	1.39	633	58.12	2.86	1299	1.65	751	57.81
	73	2.73	1241	1.65	748	60.27	3.16	1437	2.01	915	63.67
Av.		2.55	1160	1.52	692	59.71	2.96	1343	1.84	839	62.47
194	83	2.35	1066	1.35	613	57.50	2.74	1245	1.74	788	63.29
	95	2.33	1059	1.51	687	64.87	2.67	1211	1.68	764	63.09
	63	2.35	1067	1.45	660	61.85	2.78	1261	1.70	772	61.21
	71	2.25	1024	1.25	567	55.37	2.88	1309	1.65	750	57.30
Av.		2.32	1054	1.39	632	59.94	2.77	1256	1.69	768	61.16

Table 34. Whole turkey versus light meat and dark meat rolls. Weights of raw wh
dark meat rolls.

Turkey letter	Weight As purchased lbs.	g.	Ready-to-cook lbs.	g.	Whole turke Breast lbs.	%
AI	20.44	9279	18.39	8344	4.16	22.63
AL	20.13	9137	18.12	8226	3.40	18.77
AN	20.44	9279	18.48	8390	3.80	20.60
AP	21.94	9960	19.85	9012	4.13	20.80
AR	21.88	9932	19.96	9057	4.11	20.62
AT	21.69	9848	19.52	8862	3.83	19.63
Av.	21.08	9572	19.05	8648	3.90	20.51

Roll No.	Raw lbs.	g.	Cooked lbs.	g.	%
			Breast muscles		
102	6.11	2774	4.58	2083	75.09
112	5.89	2676	4.14	1881	70.29
116	4.82	2192	3.43	1560	71.16
122	5.83	2648	4.19	1903	71.86
124	5.62	2556	3.86	1755	68.66
130	5.36	2437	3.73	1695	69.55
Av.	5.60	2547	3.98	1813	71.18
			Thigh and back muscles		
103	2.39	1088	1.52	691	63.51
115	2.15	977	1.38	631	64.58
117	2.20	1002	1.34	611	60.97
121	2.48	1130	1.59	723	63.98
127	2.51	1144	1.60	725	63.37
131	2.31	1052	1.35	615	58.46
Av.	2.34	1066	1.46	666	62.47

* Percents based on ready-to-cook weights

aw whole turkeys and cooked edible meat; raw and cooked muscles, light meat and

turkey

Cooked edible meat					
Wings		Thigh and back		Legs	
lbs.	%*	lbs.	%*	lbs.	%*
0.31	1.68	1.28	6.98	0.76	4.14
0.66	3.65	1.71	9.43	9.80	4.41
0.63	3.42	1.22	9.01	1.03	5.59
0.42	2.13	1.43	7.20	0.88	4.43
0.44	2.23	1.48	7.40	0.80	4.01
0.44	2.26	1.70	8.69	0.92	4.72
0.48	2.55	1.48	8.10	0.85	4.54

Light meat rolls				
Raw		Cooked		
lbs.	g.	lbs.	g.	%
7.20	3269	5.39	2448	74.88
6.69	3039	4.81	2188	71.99
5.58	2537	4.24	1926	75.91
6.57	2983	4.80	2183	73.18
6.62	3006	4.65	2115	70.25
6.32	2870	4.44	2020	70.38
6.49	2935	4.72	2146	73.11
Dark meat rolls				
2.99	1359	1.83	835	61.44
2.58	1175	1.67	759	64.59
2.65	1204	1.63	742	61.62
2.87	1306	1.82	827	63.32
3.13	1425	1.93	879	61.68
2.81	1278	1.62	739	57.82
2.83	1291	1.75	797	61.73

Table 35. Weights of turkey skin and parts not used in the rolls

Turkey	Giblets	Neck	Wings	Legs	Fat (loose from cavity)	Skin	Bones
No.	g.	g.	g.	g.	g.	g.	g.
C	485	355	940	1011	134	963	1855
D	470	440	930	1001	174	856	1814
E	432	369	938	968	115	864	1864
F	412	334	977	1030	103	1000	1857
G	430	440	1000	1140	140	887	1940
H	424	440	940	1028	140	931	1750
I	410	340	916	1086	204	1123	2030
J	406	444	934	1114	163	1002	1950
K	370	490	951	995	150	1170	1800
L	413	348	996	1110	137	808	1858
M	464	405	1012	1164	98	880	1840
N	432	412	980	1118	93	843	1810
O	389	382	945	1258	144	968	1942
P	427	361	988	1186	0	850	2013
Q	426	476	924	1108	146	858	1862
R	448	378	1035	1288	53	766	1790
S	426	444	965	1099	147	882	1945
T	417	412	1000	1100	148	850	1870
U	424	435	936	1046	0	792	1843
V	370	386	1022	1111	77	862	1800
W	435	380	956	1070	117	780	1821
X	466	413	932	1095	100	760	1836
Y	445	408	914	1135	0	670	1849
Z	414	427	957	1001	89	730	1798
AC	406	405	900	1078	44	1057	1949
AI	462	355	---	----	---	---	----
AJ	444	436	1010	1067	0	816	1841
AL	428	370	---	----	---	---	----
AM	464	425	876	1004	147	964	1675
AN	434	342	---	----	---	---	----
AO	428	498	958	1071	112	771	1971
AP	445	392	---	----	---	---	----
AQ	442	376	919	1087	157	1046	2038
AR	359	400	---	----	---	---	----
AS	533	408	960	1094	104	1000	1883
AT	521	349	---	----	---	---	----
Average	433	399	957	1089	108	892	1870

Table 36. Light meat rolls. Linear measurements with standard deviations for raw and cooked rolls

Roll	Raw					Cooked				
	Depth	Length	Width	Girth length-wise	Girth width-wise	Depth	Length	Width	Girth length-wise	Girth width-wise
No.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
56	3.75	10.5	5.75	25	16	4.75	8.75	5.75	22.5	16
80	3.5	10.5	6	25	16	4	9	5.25	22	16.5
86	3.5	10.5	6	25.5	16	3.75	9	5.25	23	16
98	3.5	10.5	6	25	16	4	9.5	6	23.5	16
54	4	10.5	6	25	17	4.5	9.75	5.5	23	17
78	3.5	10.5	6	25	17.5	4	9	5.25	22.5	17
88	3.5	10.5	6	25.5	15.75	3.75	8.5	5.5	23.75	16.5
100	3.5	10.5	6	25	16.5	4	9	6	23	16.25
66	3.75	11	6.5	26	16	4.5	9	5.25	23.5	16
92	3.5	11	6	26.5	16.25	4	9.75	5.5	23	16
58	3.75	10	6	25	16.5	4	10	5	24.5	17
74	3.75	10.5	6	25.5	16.5	4.5	9.5	5	23.5	16
68	3.5	10.5	6	24.5	15.5	4	8.5	5.25	22	16
90	3.5	10	6	24.5	16.25	4	8.5	5.5	22.5	16
60	3.5	11	6.25	27.5	16	4	9	5.5	24.5	16
76	3.5	10.5	6	25.25	15.5	4.25	9.5	5.5	24	16
64	3.5	10	6	24.5	16	4.5	8.5	5.5	22.5	16.5
84	3.75	10.25	6	25.5	16	4	8.5	5.5	23	17
72	3.5	10.5	6.5	26	16.5	4.5	9.5	5.5	23	17
94	3.5	10.5	6	24	15	4	8.5	5.5	22.25	14.5
62	3.5	10.5	6	26	16	4.5	9	5.5	23	15.5
82	3.25	10	6	23	15.25	3.75	10	4	20	15
70	3.75	10.5	6.5	26	15.5	4	9.5	5.5	22.5	16
96	3.5	10.5	6	24.5	15	4	8	5	21.5	15.5
Av.	3.57	10.47	6.5	25.22	16.02	4.13	9.07	5.38	22.85	16.13
s	.16	.28	.41	.89	.58	.29	.54	.39	.96	.63

Table 37. Dark meat rolls. Linear measurements with standard deviations for raw and cooked rolls

Roll	Raw					Cooked				
	Depth	Length	Width	Girth length-wise	Girth width-wise	Depth	Length	Width	Girth length-wise	Girth width-wise
No.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
89	2.75	8	4.5	19	13	2.75	6.5	4	16.25	12
101	2.75	8	4.5	18.5	11.5	3	7	4	16.25	11.5
57	3	7.5	4.5	19	13	3.25	6.5	4.5	16	13
81	2.75	8	4.5	19	12.5	3	6.5	4	16	13
87	3	8	4.5	19	12.25	3.75	7	4	16.75	11.75
99	2.75	8.25	4.5	19	11.5	3	6.5	4	16.5	11.5
55	3	7.75	4.5	19.5	13	3.5	6.5	4.5	18	13
79	3	8.5	4.5	19	12.5	3	6.5	4	16.5	13
59	3	7.75	4.75	19	12.5	3.5	6.5	3.75	16	11.5
77	2.75	7.75	4.5	18.5	12	3.25	6.5	4	17	12
69	3	8.5	4.5	19	13	3.5	7	4.5	17	13
93	2.75	8	4.5	19	12.5	3.25	6.5	4	17	12.25
61	3.25	7.75	4.75	19	14	4.5	6	3.5	16.5	12
75	2.75	7.75	4.5	18.75	13	3.25	6.5	4.0	17	13.5
67	3	8.5	4.5	19	13	3.25	7	4	17	13
91	2.75	7.5	4.5	18	12.25	3.25	6	4	15.5	11.5
85	3	8	4.5	18.75	13.25	3.5	6.25	4	17.5	13.25
97	2.75	8.25	4.5	19.5	12.5	3	7	4	16.5	12
65	2.75	8	4.5	19.5	12.5	3.25	7.25	4.25	17	11.5
73	3.25	8.25	4.5	19.5	12.75	3.75	6.75	4	17.5	13
83	3	7.5	4.25	18	12.5	3.5	6.5	4	16.75	12
95	2.75	8	4.5	18	12.75	3	6	4	15.5	12
63	2.75	8	4.5	18.5	12	3.25	7	4.25	16.5	12
71	3.25	8	4.5	18.5	13	3.75	6.5	4	16.5	13.5
Av.	2.90	7.98	4.51	18.85	12.61	3.33	6.59	4.05	16.62	12.36
s	.18	.29	.09	.45	.55	.42	.34	.22	.60	.70

Table 38. Oven temperatures; cooking date, daily average and range of temperatures for each oven; roll identification in respective ovens

Temperature for which oven was set	Date of cooking	Frigidaire oven temperature			Despatch oven temperature		
		Average	Range	Rolls	Average	Range	Rolls
°F.		°F.	°F.	No.	°F.	°F.	No.
250	4/30	265	225-297	54,56	253	230-278	55,57
	5/9	260	223-278	78,80	261	241-295	79,81
	5/14	262	224-279	87,89	260	211-319	86,88
	5/21	261	240-276	99,101	262	234-278	98,100
Av.		262			259		
300	5/1	301	202-319	59,61	312	273-325	58,60
	5/6	291	255-320	66,68	303	197-318	67,69
	5/8	307	188-343	75,77	310	272-338	74,76
	5/15	322	284-353	90,92	305	281-315	91,93
Av.		305			307		
350	5/2	363	327-396	62,64	350	328-359	63,65
	5/7	355	330-380	71,73	354	310-401	70,72
	5/13	344	249-364	82,84	350	340-357	83,85
	5/20	356	336-380	95,97	331	209-376	94,96
Av.		355			346		

Table 39. Light meat rolls; roll number, raw weight, type of oven, and cooking time

End point	Roll	Raw weight	Oven*	Minutes cooking time	
°F.	No.	Lbs.		Total	Per lb.
		Oven temperature 250°F.			
176	56	6.43	F.	341	53.03
	80	6.28	F.	324	51.59
	86	6.49	D.	295	45.45
	98	5.84	D.	322	55.14
Av.		6.26		320	51.30
185	54	7.02	F.	403	57.41
	78	6.43	F.	330	51.32
	88	6.19	D.	313	50.56
	100	6.47	D.	337	52.09
Av.		6.53		347	52.84
		Oven Temperature 300°F.			
176	66	6.77	F.	241	35.60
	92	7.09	F.	240	33.85
	58	6.34	D.	235	37.07
	74	6.86	D.	236	34.40
Av.		6.76		238	35.23
185	68	5.91	F.	241	40.78
	90	6.12	F.	227	37.09
	60	7.06	D.	263	37.25
	76	6.58	D.	225	34.19
Av.		6.42		239	37.33
		Oven temperature 350°F.			
176	64	5.86	F.	195	33.28
	84	6.91	F.	210	30.29
	72	6.74	D.	201	29.81
	94	5.98	D.	185	30.94
Av.		6.37		198	31.10
185	62	6.45	F.	199	30.85
	82	5.36	F.	175	32.65
	70	6.76	D.	213	31.51
	96	6.18	D.	193	31.23
Av.		6.19		195	31.56

*F = Frigidaire oven; D = Despatch oven

Table 40. Dark meat rolls; roll number, raw weight, type of oven, and cooking time

End point	Roll	Raw weight	Oven*	Minutes cooking time	
°F.	No.	Lbs.		Total	Per lb.
		Oven temperature 250°F.			
185	89	2.79	F.	218	78.14
	101	2.57	F.	212	82.49
	57	2.67	D.	240	89.89
	81	2.69	D.	230	85.50
Av.		2.68		225	84.00
194	87	2.83	F.	236	83.39
	99	2.70	F.	239	88.52
	55	2.98	D.	287	96.31
	79	2.77	D.	240	86.64
Av.		2.82		250	88.71
		Oven temperature 300°F.			
185	59	2.64	F.	143	54.17
	77	2.63	F.	150	57.03
	69	3.09	D.	155	50.16
	93	2.77	D.	172	62.09
Av.		2.78		155	55.86
194	61	2.88	F.	155	53.82
	75	2.72	F.	167	61.40
	67	2.87	D.	173	60.28
	91	2.58	D.	172	66.67
Av.		2.76		167	60.54
		Oven temperature 350°F.			
185	85	3.06	F.	132	43.14
	97	2.75	F.	132	48.00
	65	2.86	D.	135	47.20
	73	3.16	D.	142	44.94
Av.		2.96		135	45.82
194	83	2.74	F.	132	48.17
	95	2.67	F.	132	49.44
	63	2.78	D.	140	50.36
	71	2.88	D.	150	52.08
Av.		2.77		138	50.01

*F = Frigidaire oven; D = Despatch oven

Table 41. Light meat rolls. Cooking losses in measure and percent: total, drip, and volatile

End point	Roll	Total cooking loss		Drip loss					Volatile loss	
				Total			Non fat	Fat		
°F.	No.	g.	%	c.c.	g.	%	c.c.	c.c.	g.	%
				Oven Temperature 250°F.						
176	56	671	22.97	340	348	11.91	299	41	323	11.06
	80	736	25.82	338	325	11.86	285	40	398	13.96
	86	645	21.89	333	310	11.30	260	50	312	10.59
	98	421	15.89	275	255	10.38	210	45	146	5.51
Av.		618	21.75	321	309	11.38	263	44	295	10.37
185	54	797	25.00	378	365	11.86	280	85	419	13.14
	78	667	22.93	294	286	10.07	222	64	375	12.85
	88	676	24.04	337	325	11.98	265	60	339	12.05
	100	698	23.76	309	292	10.52	267	25	389	13.24
Av.		709	23.95	329	317	11.12	258	58	380	12.84
				Oven Temperature 300°F.						
176	66	810	26.36	389	382	12.66	274	108	421	13.70
	92	874	27.14	371	355	11.52	285	70	503	15.62
	58	668	23.22	604	590	20.99	480	110	64	2.22
	74	881	28.29	518	504	16.63	414	90	363	11.66
Av.		808	26.32	470	458	15.32	363	94	338	11.00
185	68	682	25.43	329	324	12.27	229	95	253	13.16
	90	675	24.30	300	292	10.80	223	69	375	13.50
	60	680	21.21	450	435	14.04	240	95	730	7.17
	76	677	22.65	381	380	12.75	216	164	296	9.90
Av.		678	23.29	365	358	12.53	227	106	413	10.76

Table 41. (Continued)

End point	Roll	Total cooking loss		Drip loss					Volatile loss	
				Total			Non fat	Fat		
°F.	No.	g.	%	c.c.	g.	%	c.c.	c.c.	g.	%
				Oven Temperature 350°F.						
176	64	759	28.52	355	354	13.34	255	99	404	15.18
	84	970	30.91	309	286	9.85	238	48	661	21.06
	72	889	29.04	394	380	12.87	297	83	495	16.17
	94	777	28.60	231	225	8.50	163	62	546	20.10
Av.		849	29.32	322	311	11.13	238	73	526	18.19
185	62	885	30.20	380	427	14.57	295	85	458	15.63
	82	782	32.13	284	285	11.71	176	108	497	20.42
	70	984	32.04	486	499	16.25	336	150	485	15.79
	96	844	30.09	232	244	8.70	158	74	600	21.39
Av.		874	31.09	345	364	12.94	241	104	510	18.15

Table 42. Dark meat rolls. Cooking losses in measure and percent: total, drip, and volatile

End point	Roll	Total Cooking Loss		Drip Loss					Volatile Loss	
				Total			Non Fat	Fat		
°F.	No.	g.	%	c.c.	g.	%	c.c.	c.c.	g.	%
				Oven Temperature 250°F.						
185	89	442	34.91	265	268	21.17	195	70	174	13.74
	101	370	31.73	170	164	14.06	160	10	206	17.67
	57	443	36.49	268	265	21.83	200	68	178	14.66
	81	394	32.24	218	217	17.76	185	33	177	14.48
Av.		412	33.87	230	228	18.78	185	45	184	15.10
194	87	500	38.88	300	302	23.48	203	97	198	15.40
	99	457	37.31	230	229	18.69	195	35	228	18.61
	55	516	38.19	240	296	21.91	140	100	220	16.28
	79	380	30.25	272	202	16.08	213	59	178	14.17
Av.		463	36.20	260	257	20.10	188	73	206	16.10
				Oven Temperature 300°F.						
185	59	582	48.62	296	395	33.00	210	86	187	15.62
	77	406	34.00	192	196	16.41	160	32	210	17.59
	69	501	35.66	368	379	26.12	240	128	134	9.54
	93	478	38.06	250	265	21.10	210	40	213	16.96
Av.		492	38.93	276	309	24.21	205	71	186	14.73
194	61	542	41.47	335	337	25.78	234	101	205	15.68
	75	381	30.85	236	239	19.35	176	60	142	11.50
	67	483	37.07	306	310	23.79	232	74	173	13.28
	91	451	38.55	214	217	18.55	165	49	234	20.00
Av.		464	37.03	273	276	21.99	202	71	161	15.03

Table 42. (Continued)

End point	Roll	Total Cooking Loss		Drip Loss					Volatile Loss	
				Total			Non Fat	Fat		
°F.	No.	g.	%	c.c.	g.	%	c.c.	c.c.	g.	%
				Oven Temperature 350°F.						
185	85	453	32.61	220	220	15.84	175	45	233	16.77
	97	493	39.53	222	225	18.04	140	82	268	21.49
	65	548	42.19	300	299	23.02	195	105	249	19.17
	73	522	36.33	278	275	19.14	204	74	247	17.19
Av.		504	27.53	255	255	18.97	178	76	249	18.56
194	83	457	36.71	250	268	21.53	170	80	189	15.18
	95	447	36.91	196	198	16.35	128	68	249	20.56
	63	489	38.78	247	247	19.59	140	107	242	19.19
	71	559	42.70	348	339	25.90	144	204	220	16.81
Av.		488	38.84	260	263	20.93	145	115	225	17.91

Table 43. Light meat rolls; Judges' mean scores for aroma, flavor, tenderness, and juiciness by judges, end points, and oven temperatures

Judges	Aroma	Flavor	Tenderness	Juiciness	Aroma	Flavor	Tenderness	Juiciness
	End point 176°F.				End point 185°F.			
	Oven temperature 250°F.							
Judge A	5.2	5.8	8.6	6.8	5.5	5.2	8.4	6.8
Judge B	6.0	5.0	7.3	7.3	6.0	4.0	7.3	7.0
Judge C	3.0	5.8	5.5	4.8	2.5	5.5	7.0	6.8
Judge D	5.8	5.0	6.8	6.8	5.0	5.0	7.5	7.0
Judge E	6.0	7.8	7.3	7.3	6.8	9.0	9.5	8.8
Judge F	6.8	7.3	7.8	6.0	4.5	6.5	9.3	4.8
Judge G	4.1	4.3	8.0	7.8	3.5	3.6	8.3	7.8
Av.	5.3	5.7	7.3	6.6	4.8	5.5	8.2	7.0
	Oven temperature 300°F.							
Judge A	4.5	4.5	8.8	6.5	5.0	5.5	8.4	7.6
Judge B	5.5	6.3	8.0	6.5	7.0	7.0	7.8	8.0
Judge C	2.8	4.3	6.8	7.0	2.0	5.5	6.3	6.8
Judge D	4.8	4.8	5.5	5.3	4.8	4.3	5.5	6.3
Judge E	5.6	7.4	7.7	6.5	7.0	7.8	8.3	7.3
Judge F	7.0	7.3	8.5	3.8	5.0	6.3	9.0	5.0
Judge G	3.4	3.3	8.5	7.0	3.6	3.1	8.5	7.0
Av.	5.0	5.4	7.5	6.1	4.8	5.6	7.7	6.9
	Oven temperature 350°F.							
Judge A	5.8	6.4	7.5	6.4	4.8	6.3	8.0	5.9
Judge B	7.0	5.8	6.5	6.8	6.8	6.0	7.8	6.3
Judge C	2.0	4.3	6.5	6.0	2.8	4.0	6.8	6.3
Judge D	4.3	4.3	6.3	5.8	5.5	4.8	6.0	4.5
Judge E	7.5	7.5	6.5	7.0	6.8	7.3	7.3	6.3
Judge F	5.3	4.0	7.5	4.8	5.8	4.8	8.0	4.0
Judge G	3.4	3.3	7.5	6.8	3.3	3.1	8.0	6.8
Av.	5.0	5.0	6.9	6.2	5.1	5.2	7.4	5.7

Table 44. Dark meat rolls. Judges' mean scores for aroma, flavor, tenderness, and juiciness by judges, end points, and oven temperatures

Judges	Aroma	Flavor	Tenderness	Juiciness	Aroma	Flavor	Tenderness	Juiciness
	End point 185°F.				End point 194°F.			
	Oven temperature 250°F.							
Judge A	5.4	5.9	7.8	7.9	5.8	5.8	8.5	7.9
Judge B	7.0	5.0	7.0	7.5	7.0	5.0	8.8	8.5
Judge C	2.0	6.8	6.3	6.3	3.0	7.3	7.5	7.8
Judge D	6.0	5.8	6.8	7.8	5.2	5.5	7.8	7.8
Judge E	8.0	7.8	7.0	7.5	7.0	8.5	8.8	8.5
Judge F	2.3	8.3	5.0	6.5	4.5	8.8	7.8	8.0
Judge G	4.9	3.9	6.5	8.3	5.3	4.3	8.0	8.5
Av.	5.1	6.3	6.7	7.4	5.4	6.4	8.1	8.1
	Oven temperature 300°F.							
Judge A	5.8	6.0	8.0	7.8	4.8	5.5	7.8	7.0
Judge B	8.3	6.0	7.8	8.5	7.5	7.5	8.3	7.5
Judge C	2.5	5.0	5.5	5.5	1.8	5.0	6.8	7.0
Judge D	5.0	5.0	6.5	7.0	5.0	5.3	5.8	5.8
Judge E	7.5	6.8	6.5	7.3	6.8	8.0	7.0	7.3
Judge F	2.3	7.3	6.5	7.8	5.8	7.5	7.3	6.8
Judge G	3.8	4.0	8.5	8.8	4.0	3.9	8.0	8.5
Av.	5.0	5.7	7.0	7.5	5.1	6.1	7.2	7.1
	Oven temperature 350°F.							
Judge A	6.3	7.0	8.0	7.2	6.0	6.5	8.3	7.8
Judge B	7.5	7.0	7.5	7.8	6.8	6.8	8.3	7.8
Judge C	2.3	5.8	6.8	7.0	3.0	5.0	5.8	6.0
Judge D	4.3	4.5	6.3	7.5	5.0	5.0	7.8	8.3
Judge E	7.0	7.0	6.5	7.3	6.3	7.8	6.8	7.3
Judge F	5.0	7.5	6.8	6.0	4.8	7.3	7.3	6.5
Judge G	3.8	4.0	7.5	8.3	3.3	3.8	8.0	8.3
Av.	5.4	6.1	7.0	8.1	4.9	6.0	7.4	7.4

Table 45. Light meat rolls. Judges' mean scores for aroma, flavor, tenderness, and juiciness by replications, end points, and oven temperatures

Replications	Aroma	Flavor	Tenderness	Juiciness	Aroma	Flavor	Tenderness	Juiciness
		End point 176°F.				End point 185°F.		
				Oven temperature 250°F.				
1	5.4	6.3	7.7	7.3	4.0	5.7	8.6	7.3
2	4.7	5.6	6.7	6.1	5.8	5.5	8.1	6.9
3	6.0	6.0	7.6	7.0	5.1	5.8	8.1	6.3
4	4.9	5.1	7.3	6.1	4.3	5.1	7.8	7.3
Av.	5.3	5.7	7.3	6.6	4.8	5.5	8.2	7.0
				Oven temperature 300°F.				
1	5.6	5.3	7.1	6.0	4.8	5.3	7.8	7.5
2	4.4	5.3	7.6	6.4	5.3	5.3	7.3	6.8
3	4.7	5.7	8.8	6.1	4.7	6.1	8.5	6.8
4	5.1	5.3	6.3	5.7	4.5	5.7	7.0	6.4
Av.	5.0	5.4	7.5	6.1	4.8	5.6	7.7	6.9
				Oven temperature 350°F.				
1	4.8	4.8	8.4	6.8	4.6	4.6	8.0	5.1
2	4.8	4.1	5.6	5.2	5.3	5.3	7.3	6.3
3	4.8	5.2	5.6	7.0	6.0	5.8	6.8	5.4
4	5.7	6.0	8.0	6.7	4.6	4.8	7.4	7.0
Av.	5.0	5.0	6.9	6.2	5.1	5.2	7.4	5.7

Table 46. Dark meat rolls. Judges' mean scores for aroma, flavor, tenderness, and juiciness by replications, end points, and oven temperatures

Replications	Aroma	Flavor	Tenderness	Juiciness	Aroma	Flavor	Tenderness	Juiciness
	End point 176°F.				End point 185°F.			
	Oven temperature 250°F.							
1	4.3	6.2	6.8	8.3	5.2	6.6	8.8	8.1
2	5.1	5.8	6.0	6.7	5.6	6.7	8.8	8.1
3	6.5	7.1	7.1	7.5	5.7	6.7	8.8	8.8
4	4.3	5.7	6.7	7.0	5.0	5.7	6.8	7.3
Av.	5.1	6.2	6.7	7.4	5.4	6.4	8.1	8.1
	Oven temperature 300°F.							
1	5.1	6.0	7.3	7.3	4.8	6.3	8.0	8.0
2	5.0	5.2	5.6	6.6	5.2	6.1	6.7	6.3
3	5.0	5.6	7.8	8.3	5.1	5.5	7.4	6.8
4	4.8	6.0	7.4	7.8	5.0	6.4	6.8	7.3
Av.	5.0	5.7	7.0	7.5	5.1	6.1	7.2	7.1
	Oven temperature 350°F.							
1	4.8	5.2	6.0	6.4	4.5	5.8	8.0	7.6
2	5.0	6.4	7.7	7.5	5.6	6.4	7.6	7.4
3	5.9	6.6	7.3	7.3	5.4	6.6	7.6	7.6
4	4.8	6.1	7.1	7.3	4.1	5.1	6.6	7.0
Av.	5.1	6.1	7.0	7.1	4.9	6.0	7.4	7.4

Table 47. Whole turkey versus light meat and dark meat rolls. Raw weights and cooking time

Whole turkey				Light meat rolls				Dark meat rolls			
Turkey	Weight ready-to-cook	Cooking time total	min./lb.	Roll	Weight Raw	Cooking time total	min./lb.	Roll	Weight Raw	Cooking time total	min./lb.
letter	lbs.	min.	min.	no.	lbs.	min.	min.	no.	lbs.	min.	min.
AI	18.39	275	14.95	102	7.20	281	39.03	103	2.99	201	67.22
AL	18.12	264	14.57	112	6.69	250	37.37	105	2.58	165	63.95
AN	18.48	294	15.91	116	5.58	225	40.32	117	2.65	190	71.70
AP	19.85	300	15.11	122	6.57	235	35.77	121	2.87	165	57.49
AR	19.96	328	16.43	124	6.62	270	40.78	127	3.13	187	59.74
AT	19.52	270	13.83	130	6.32	230	36.39	131	2.81	190	67.62
Av.	19.05	288	15.13		6.49	248	38.21		2.83	183	64.66

Table 48. Whole turkeys versus light meat and dark meat rolls. Cooking losses in measure and percent: total, drip, and volatile

Turkey	Total			Drip		Non fat	Fat	Volatile	
letter	g.	%	c.c.	g.	%	c.c.	c.c.	g.	%
				Whole turkeys					
AI	2079	24.84	1395	1367	16.34	---	---	712	8.50
AL	2138	25.99	1036	1081	13.14	---	---	1057	12.85
AN	1884	22.46	880	894	10.21	---	---	990	12.25
AP	2688	29.83	1630	1594	17.69	---	---	1094	12.14
AR	2182	31.93	1740	1720	18.99	---	---	1172	12.94
AT	2529	28.54	1270	1239	12.84	---	---	1290	15.70
Av.	2250	27.38	1325	1316	15.21	---	---	1052	12.17
				Light meat rolls					
Roll No.									
102	821	25.11	494	453	13.85	340	154	368	11.26
112	851	28.00	430	441	14.51	390	40	410	13.49
116	611	24.08	310	322	12.69	255	55	289	11.39
122	800	26.81	450	465	15.58	375	75	335	11.23
124	891	29.64	450	464	15.44	370	80	427	14.20
130	850	29.61	435	449	15.64	335	100	401	13.97
Av.	804	27.39	428	432	14.72	344	84	371	12.66

Table 48. (Continued)

Turkey	Total			Drip		Non fat	Fat	Volatile	
	g.	%	c.c.	g.	%	c.c.	c.c.	g.	%
				Dark meat rolls					
103	524	38.55	370	379	27.88	245	125	145	10.67
115	416	35.40	240	246	20.94	195	45	170	14.46
117	462	38.37	275	279	23.17	195	60	183	15.20
121	479	36.67	310	315	24.11	230	80	164	12.56
127	546	38.31	360	363	25.47	250	110	183	12.84
131	499	39.04	310	314	24.56	190	120	185	14.48
Av.	487	37.76	310	316	24.47	217	90	155	12.00

Table 49. Whole turkey versus light meat and dark meat rolls. Judges' mean scores for aroma, flavor, tenderness, and juiciness by judges

Judges	Aroma	Flavor	Tenderness	Juiciness	Aroma	Flavor	Tenderness	Juiciness
	Whole turkey				Light meat rolls			
Judge A	5.3	5.6	7.9	8.9	5.7	6.1	8.5	7.3
Judge B	5.3	4.5	7.2	7.7	5.3	5.0	7.3	7.0
Judge C	2.1	7.7	7.7	7.5	3.0	6.8	7.0	6.1
Judge D	4.5	5.3	5.7	5.7	5.4	5.8	5.8	5.8
Judge E	7.7	8.3	7.7	8.0	7.8	8.0	7.5	7.3
Judge F	4.8	4.7	7.7	8.5	4.4	4.1	8.0	6.8
Judge G	5.8	6.1	7.5	7.8	7.0	6.0	7.2	6.8
Av.	5.2	6.3	7.3	7.7	5.6	6.0	7.3	6.7
	Whole turkey				Dark meat rolls			
Judge A	6.0	6.0	8.6	8.3	6.0	5.7	9.3	8.5
Judge B	5.3	6.3	7.7	7.8	5.4	5.7	7.2	7.2
Judge C	2.0	8.1	8.6	8.7	2.5	7.3	7.7	7.5
Judge D	5.4	6.8	7.5	7.2	5.1	6.3	6.8	7.0
Judge E	8.3	8.8	8.3	8.7	8.1	8.1	8.1	8.0
Judge F	4.8	5.1	8.5	7.8	4.8	3.8	7.3	7.2
Judge G	7.8	7.5	8.0	7.8	9.0	7.8	8.0	7.3
Av.	5.6	6.9	8.1	8.0	5.6	6.6	7.8	7.5

Table 50. Whole turkey versus light meat and dark meat rolls. Judges' mean scores for aroma, flavor, tenderness, and juiciness by replications

Replications	Aroma	Flavor	Tenderness	Juiciness	Aroma	Flavor	Tenderness	Juiciness
	Whole turkey			Light meat	Light meat rolls			
1	5.1	5.8	7.4	7.4	5.6	6.1	8.6	8.1
2	5.3	6.1	7.4	7.3	5.0	5.7	6.5	5.3
3	4.7	6.0	9.0	9.4	5.4	6.6	7.7	7.3
4	5.3	5.3	5.8	6.5	5.8	5.8	6.2	6.5
5	6.0	7.0	7.8	8.3	6.0	6.4	8.0	7.3
6	5.0	6.0	6.3	7.4	5.3	5.7	7.0	6.0
Av.	5.2	6.3	7.3	7.7	5.5	6.0	7.3	6.7
	Whole turkey			Dark meat	Dark meat rolls			
1	4.6	5.3	6.1	6.6	6.0	6.9	8.7	8.1
2	5.0	7.1	7.5	8.0	5.1	5.8	6.2	7.0
3	5.7	8.0	9.1	9.1	5.6	6.7	8.4	8.0
4	6.1	7.2	8.7	8.4	5.8	6.6	7.7	7.1
5	6.4	7.6	8.7	8.0	5.8	6.6	7.2	7.4
6	6.0	6.5	8.7	8.1	5.4	7.1	8.4	7.4
Av.	5.6	6.9	8.1	8.0	5.6	6.6	7.8	7.5

Figure 21. Form for collecting data

I. Losses by weight — Grams

A. Before cooking

1. Weight of frozen bird
2. Weight of bird after thawing
3. Weight of thawed bird without giblets and neck or roll
4. Weight of pan and rack
5. Weight of pan, rack, and roll

B. After cooking

1. Weight of pan, rack, roll, and drippings
2. Volatile loss (A5-B1)
3. Weight of cooked roll (B1-B5)
4. Weight of cooked bird
5. Weight of pan, rack, and drippings
6. Total cooking loss
   a. Roll (B3-B1)
   b. Turkey (B4-A3)
7. Dripping loss
   a. Roll (B1-A4)
   b. Whole turkey (B5-A4)

II. Losses as percent of weight — Percent

A. Total cooking loss (B+A3)

B. Drip loss (B7-IIA)

C. Volatile loss (B2+IIA)

Figure 22. Score card for turkey

Name _____

Score Card for Turkey

Date _____

Time _____

Score on the basis of 10 to 0

	Scores			
Sample Number				
Aroma				
Off Odor				
Flavor				
Off Flavor				
Tenderness				
Juiciness				

Doneness	Please check ( ) degree of doneness			
Underdone				
Done				
Overdone				

Remarks _____

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APPENDIX B

Table 51. Light meat and dark meat rolls. Analyses of variance for minutes per pound cooking time

Source of variation	Degrees of freedom	Mean squares Light meat	Dark meat
Ovens (A)	1	13.8017	82.1770
Oven temperature (B)	(2)	938.8625***	3168.7649**
Linear	1	1720.7978***	5911.6877**
Quadratic	1	156.9272**	425.8421**
End points (C)	1	11.1794	122.9895**
A x B	2	1.5493	12.8463
A x C	1	2.8981	4.8511
B x C	2	1.3961	.1684
A x B x C	2	3.5679	6.4856
Error	12	7.5632	18.3382

**Highly significant at the 1 percent level

***Very highly significant at the 1 percent level

Table 52. Light meat and dark meat rolls. Analyses of variance for yields of cooked edible meat

Source of variation	Degrees of freedom	Light meat		Dark meat	
		Mean squares			
		Percent yield Cooked edible meat		Percent yield Cooked edible meat	
		With skin	Without skin	With skin	Without skin
Ovens (A)	1	17.2212	.5557	2.6600	.9361
Oven temperature (B)	2	118.7297**	105.6126*	37.6319	93.9845
Linear	1	223.2783**	204.4900**	59.1746	160.0225*
Quadratic	1	14.1810	6.7350	16.0892	27.8465
End points (C)	1	.8778	1.3680	.0040	2.7608
A x B	2	2.3626	2.6380	13.3486	7.6525
A x C	1	3.5651	.6049	3.2634	.0113
B x C	2	15.7694	3.0814	6.7799	2.9948
A x B x C	2	7.6396	5.5528	9.2736	10.0080
Error	12	4.7693	15.9513	22.2924	26.8116

*Significant at the 5 percent level

**Highly significant at the 1 percent level

Table 53. Light meat and dark meat rolls. Analyses of variance for cooking losses: total, drip, and volatile

Source of variation	Degrees of freedom	Total losses Mean squares Light meat	Total losses Mean squares Dark meat	Drip losses Mean squares Light meat	Drip losses Mean squares Dark meat	Volatile losses Mean squares Light meat	Volatile losses Mean squares Dark meat
Ovens (A)	1	18.3575*	.3700	6.5000	5.1245	46.7325	2.7880
Oven temperature (B)	(2)	117.0181***	26.1518	15.8574	30.7749	131.9520**	24.1454
Linear	1	219.2621**	41.4736	2.1831	1.2266	177.8223**	28.4889
Quadratic	1	14.7741	10.8300	29.5317*	60.3232	86.0816*	19.8018
End points (C)	1	1.0966	1.1704	1.6485	.5133	5.4245	.1176
A x B	2	2.6862	16.4508	15.9186	14.7706	21.6582	.9299
A x C	1	3.0744	.6144	1.7986	4.0099	9.5887	7.9120
B x C	2	16.2600*	10.4161	10.9316	10.1278	3.7893	1.4415
A x B x C	2	6.9602	15.1838	5.4328	2.6038	1.6432	6.7564
Error	12	3.8159	21.9091	5.2824	24.1593	10.0170	8.5816

*Significant at the 5 percent level

**Highly significant at the 1 percent level

***Very highly significant at the 1 percent level

Table 54. Light meat and dark meat rolls. Analyses of variance for aroma, flavor, tenderness, and juiciness

Source of variation	Degrees of freedom	Light meat rolls Mean squares				Dark meat rolls Mean squares			
		Aroma	Flavor	Tender-ness	Juici-ness	Aroma	Flavor	Tender-ness	Juici-ness
Ovens (A)	1	.030	.51	.03	.00	.08	.00	.03	.02
Oven temper-atures (B)	2	.075	.69	.73	.72	.11	.44	.63	.70
Linear	1	.010	1.27*	1.38	1.44	.16	.53	.08	.86
Quadratic	1	.140	.11	.08	.00	.06	.35	.17	.54
End points (C)	1	.150	.00	1.55	.30	.01	.11	2.87	.46
A x B	2	.230	.54	.16	.69	.075	.00	.22	.08
A x C	1	.190	.01	.19	.10	.37	.78	1.89	.18
B x C	2	.155	.10	.21	.86	.25	.195	1.00	.36
A x B x C	2	.025	.21	.06	.00	.01	.05	.01	.12
Error	12	.389	.199	1.03	.46	.437	.335	.61	1.74

*Significant at the 5 percent level

Table 55. Light meat rolls. Judges' mean scores for tenderness *versus* mean shear force values

Roll No.	Tenderness Average score	Shear value Average
54	8.6	2.1
58	8.5	3.4
64	8.4	2.4
66	7.1	3.8
70	6.8	3.8
74	6.3	3.5
80	6.7	2.8
82	7.3	5.1
88	8.1	2.6
90	7.3	3.0
94	8.0	3.2
98	7.3	2.9

Table 56. Whole turkeys *versus* light meat and dark meat rolls. Analyses of variance for aroma, flavor, tenderness, and juiciness

Source of variation	Degrees of freedom	Light meat rolls Mean squares Aroma	Flavor	Tenderness	Juiciness	Dark meat rolls Mean squares Aroma	Flavor	Tenderness	Juiciness
Whole/roll	1	.24	.0	.01	2.81	.0	.34	.40	.86
Error	10	.16	.23	1.07	1.02	.29	.55	1.09	.44