May 15, 1963

To the Graduate Council:

I am submitting herewith a thesis written by Betty Louise Boyd entitled "A Comparison of Open-Pan and Foil-Wrap Methods of Roasting Yearling Turkey." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Foods and Institution Management.

Bernadine Meyer
Major Professor

We have read this thesis and recommend its acceptance:

Betty Duncan

Claire Gilbert

Accepted for the Council:

Dean of the Graduate School

A COMPARISON OF OPEN-PAN AND FOIL-WRAP METHODS OF ROASTING YEARLING TURKEY

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

Betty Louise Boyd

June 1963

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CHAPTER I

INTRODUCTION

Frequently yearling turkeys are available in the retail market during the spring and summer and often may be obtained at a reasonable price. According to the Poultry Division of the Agricultural Marketing Service (Hauver and Kilpatrick, 1961), yearling turkeys are fully matured when slaughtered, "usually under 15 months of age" and are "reasonably tender-meated" and have "reasonably smooth-textured skin." Theoretically, yearling birds have more connective tissue than younger turkeys, and this raises the question as to whether ordinary dry-heat roasting is appropriate or whether a method which is more conducive to tenderization should be used. A great deal of research has been conducted in recent years in the area of poultry cookery. However, very little has been done involving the yearling turkey.

Many homemakers have suggested that cooking turkey in aluminum foil produces a tender, juicy product that requires less cooking time. Also, they have indicated that this method is labor-saving, because there is no spattering of drippings on the walls of the oven. It was felt that these beliefs merited investigation, since there has been only a limited amount of experimental work on cooking poultry in aluminum foil.

This study was undertaken to compare the effects of roasting fully matured yearling turkeys by open-pan and foil-wrap methods. It was based on the hypothesis that cooking poultry in aluminum foil holds in steam and therefore promotes an increase in tenderness.

Differences in cooking losses, fuel consumption, cooking time, yield of edible meat, shear values, and heat penetration were determined. Estimates of tenderness, juiciness, flavor and consumer preference were obtained through sensory tests. It was hoped that results would provide a usable guide for homemakers regarding an acceptable method of roasting yearling turkey.

CHAPTER II

REVIEW OF LITERATURE

A great deal of research has been done in the area of poultry cookery. However, very little has been done involving the yearling turkey. Research on poultry cookery in general will be reviewed in order that the findings of other investigators may be related to work done in the present study.

In the following review, cooking procedures will be discussed with respect to studies of cooking temperature and cooking losses, end-point of cooking, cooking in foil and cooking the yearling turkey. Also, research involving tenderness determinations and yield of edible meat will be discussed.

I. COOKING PROCEDURES

Some of the earliest research on cooking poultry was done by Lowe and Keltner (1937) when they reported the results of a study designed to determine the effect of using covered and uncovered pans in roasting chicken halves. It was found that breasts of uncovered halves were superior to those of covered halves in aroma, flavor, and juiciness. Covering for the last 20 minutes of the cooking period shortened the cooking time, decreased the cooking losses, and increased the tenderness and palatability of the skin, but not of the meat. Thigh muscles of halves roasted either covered or uncovered were scored equivalent on palatability.

Cooking Temperature and Cooking Losses

Based on research conducted at the Bureau of Home Economics in the United States Department of Agriculture, Alexander (1941) recommended roasting turkey in a shallow pan without a cover, blanket of cloth or dough. She recommended that the oven temperature be based on the weight of the bird. An oven temperature of 325° was recommended for six to nine pound turkeys, and the recommended temperature was decreased with increased bird size. This procedure has been used extensively in poultry research through the years.

Goertz and Stacy (1960) roasted half and whole turkeys at 300, 325, or 350° F to an internal temperature of 194° F in the pectoralis major muscle. Cooking losses and cooking time were significantly greater for half turkeys roasted at 300 and 325° F than for half birds cooked at 350° F. Dripping losses, press fluid yields, and shear values were unaffected by the oven temperature. The authors suggested that when turkeys were roasted to an end-point temperature of 194° F in the breast muscle, oven temperatures of 325 and 350° F were most satisfactory for both whole and half turkeys. Goodwin, et al. (1962) found that rate of cooking had no significant effect on shear values of turkeys.

End-Point of Cooking

Through the years, many different methods of determining the doneness of poultry have been suggested for use in the home. However, for research, the internal temperature of the bird is determined by using thermocouples or thermometers. Recent studies have sought to

relate end-point temperature with doneness.

Alexander, et al. (1951a) roasted 15 turkeys of different varieties, crosses, and ages to different stages of doneness. Interior temperatures in the thigh, breast, and stuffing were recorded to relate temperature to doneness. For satisfactorily cooked turkeys, thigh temperatures varied from 194 to 201° F and breast temperatures from 176 to 203° F. In general, the smaller the weight of turkey, the higher the temperature required. For eight male turkeys which were not satisfactorily cooked, the thigh temperatures of seven were within the range of 176 to 190° F, and one reached 203° F. Breast temperatures of underdone birds varied from 160 to 180° F. However, the authors felt that this study did not justify recommending a specific end-point temperature as the best means for determining when a turkey is done throughout, because information is needed on rate of heat penetration as well as on temperature reached in various portions of turkeys of different age, weight, and conformation.

Goertz, et al. (1960a) investigated certain end-point temperatures in both the breast and thigh to determine which would produce most consistently a bird of desirable doneness. Eighty frozen-defrosted Broad Breasted Bronze turkey halves were roasted at 325° F to an end-point temperature of 185 to 194° F in the pectoralis major and 185, 194, and 203° F in the thigh. Turkey halves roasted to either 194° F in the pectoralis major or 203° F in the thigh were satisfactorily done. However, an end-point temperature of 194° F in the pectoralis major was preferred to 203° F in the thigh because of the size and greater

uniformity of the pectoralis major muscle. Flavor and tenderness scores were similar for birds cooked to all end-point temperatures. Juiciness scores and press-fluid yields were lower and cooking losses higher for satisfactorily done than for underdone turkey halves. The amount of heat-coagulable protein in the pectoralis major was not related to the doneness of the muscle.

Goertz, et al. (1960b) concluded that total cooking time was longer for fresh-frozen turkeys roasted to 203° F in the thigh than for those roasted to 194° F in the breast muscle. Similar results for cooking time were obtained with fresh-unfrozen turkeys.

Goodwin, et al. (1962) of the Departments of Animal Sciences and Foods and Nutrition at Purdue University investigated the effects of end-point temperature and cooking rate on turkey-meat tenderness. The turkeys were wrapped in aluminum foil and cooked to end-point temperatures of 131, 140, 151, 160, 171, 180, 190, and 201° F in the thickest part of the breast muscle. No significant differences were found in shear values of turkeys with end-point temperatures ranging from 171 to 201° F, but meat cooked to only 131° F had significantly higher shear values than meat cooked to 171° F or above. Breast muscle cooked to 190 and 201° F appeared drier and tended to crumble and fall apart more than that cooked to lower end-point temperatures.

Cooking in Foil

In 1953, Lowe, et al. compared foil-wrapped turkeys (450° F) with non-wrapped turkeys cooked at traditional temperatures (300 to 325° F). Both methods produced turkeys of comparable aroma, flavor,

tenderness, and juiciness although there were differences in losses due to drippings and evaporation. The foil-wrapped turkeys had more drippings and less loss of moisture due to evaporation. The authors listed the following advantages and disadvantages of cooking turkey in aluminum foil:

Advantages

Prevents spattering of drippings over the oven.
No special rack or equipment is needed.
Foil prevents burning of the turkey; thus, a high oven temperature which shortens the cooking time may be used.
Less loss of moisture and more drippings saved for making gravy.

Disadvantages

Does not give as good a browned appearance, particularly along the back.
Muscles may pull away from bones.
More fuel required because of the high temperature used.

At an oven temperature of 450° F, 15 to 16 minutes per pound were required for foil-wrapped turkeys weighing eight to ten pounds, while only eight to nine minutes per pound were needed for 20 to 24 pound turkeys.

In an investigation similar to the one conducted by the author of this report in which young turkeys were roasted by open-pan and foil-wrap methods, Majhor (1962) found that both methods produced acceptable products in regard to appearance and flavor. A taste panel scored light meat from the open-pan method slightly more juicy and the dark meat slightly more tender. Preference tests indicated that both light and dark meat from halves roasted by open-pan method were highly preferred. No differences were found in cooking losses and yield of edible meat. The greatest difference between the two methods was in cooking time and power consumption. Total cooking time was reduced about 25 per cent when the foil-wrap

method was used. Turkeys roasted by the open-pan method required an average 24.7 minutes per pound while foil-wrapped birds required 19.4 minutes per pound. Power consumption averaged approximately 0.1 kilowatt-hour per pound more for the turkey roasted in foil. Total power consumption was increased about 23 per cent when the foil-wrap method was used. She recommended that a choice between the two methods of roasting turkey would be a matter of personal decision as to the relative importance of the differences observed in this study.

It is interesting to note that although Lowe, et al. (1953) reported no marked differences in palatability of poultry cooked by open-pan and foil-wrap methods, in 1955 she postulated that when turkeys are cooked covered or in foil, the steam is held around the bird and the collagen is converted to gelatin more rapidly than in dry-heat cookery. Chemical analysis of the collagen content before and after roasting might help to provide an answer to the question regarding differences in poultry roasted by open-pan and foil-wrap methods.

Cooking Yearling Turkey

Niles (1936) of the Poultry and Egg National Board recommended that yearling turkeys be cooked at a moderate temperature (300 to 350° F) for the entire cooking period, or seared at a high temperature (450 to 475° F) for a short period followed by roasting at a moderate temperature. She recommended that fully matured birds be cooked in a covered pan or in a dough blanket during the first part of the roasting period and uncovered during the latter part of cooking to crisp the skin and allow for satisfactory browning.

Swickard, et al. (1961) reported that fully matured hen or tom turkeys have hardened breastbones, coarse skin and are less tender than young hen or tom turkeys. They recommend that yearling birds be cooked by braising in a covered roaster or in a pressure cooker.

II. TENDERNESS DETERMINATIONS

For many years tenderness was measured only subjectively by taste panels due to the lack of appropriate objective measurements. However, several good shearing devices designed for use with meat are now being tested for use with poultry. Recent studies have included both methods of evaluating tenderness of turkeys.

Klose, et al. (1959) investigated the tenderness of turkeys as influenced by conditions of aging, scalding, and picking. These investigators sheared a 1 x 1-inch cross section of the pectoralis major cut out parallel to the grain and one-inch from the anterior edge. Six successive shears, across the grain of the muscle strip and spaced at one-half inch intervals along its length were made on a Warner-Bratzler type shearing apparatus, providing 12 shear-force values for each bird. Shear values were found to be relatively good indices of toughness as subjectively expressed by the ranking of a trained taste panel.

Goertz, et al. (1961) in an investigation of tenderness scores and shear values for broilers and Beltsville White turkeys fed different cereal grains, sheared one-inch cores from the pectoralis major muscle. Subjective evaluation of tenderness was based on the number of chews needed to completely masticate similar-sized samples of the

breast (pectoralis major) and thigh (gluteus primus) muscles. They obtained significant correlation coefficients between tenderness scores and shear values.

III. YIELD OF EDIBLE MEAT

Much research has been done to investigate the yield of edible meat from different types of poultry. Alexander, et al. (1951b) of the Bureau of Human Nutrition and Home Economics compared edible yield of turkey according to sex, age, fatness, and breast type. Age of the turkey significantly influenced the yield of cooked edible meat. Yield increased with age for males but tended to decrease with females. The turkeys for which data were available were classified according to breast type (broad, medium, narrow) and fat grades, and the yields of cooked muscles were examined. They found that in general, the broader the breast type the greater was the percentage yield of cooked muscle.

Swickard and Harkin (1954) compared yields of 14 to 16-week old "fryer-roasters" and 26-week old "young tom turkeys." The yield for toms 14 weeks old averaging 4.8 pounds was 53.9 per cent; for hens 16 weeks old averaging 4.4 pounds, 54.8 per cent; and for toms 26 weeks old averaging 11.3 pounds, 55.5 per cent. These yields included skin and fat and the differences were not significant.

Similar figures for percentage of edible meat were reported by Winter and Clements (1957) from research conducted at the Ohio Agricultural Experiment Station. Small turkeys (Beltsville White - Wahkeen crosses) and large turkeys of the extremely Broad Breasted Bronze type

were wrapped in aluminum foil and steamed in an autoclave. Yields, including skin and fat, averaged 54.0 per cent for the small turkeys and 56.7 per cent for the large turkeys.

Dawson, et al. (1958) presented data on yields of edible meat from beef, pork, veal, lamb, turkey, and chicken. Ready-to-cook turkeys (without neck and giblets) roasted at 300 to 350° F gave approximately the same yield of cooked edible meat as steamed turkeys. Tom turkeys of light, medium and heavy weight groups yielded about the same percentage of cooked meat without skin and fat, averaging from 38 to 42 per cent. The large ready-to-cook Broad Breasted Bronze turkeys yielded an average of 46 per cent cooked meat without skin. Beltsville Small White tom turkeys weighing about five pounds had an average yield of 54 per cent cooked meat including skin and fat, while the hens averaged 55 per cent. Toms that weighed approximately 11 pounds had an average yield of 56 per cent edible meat including skin and fat.

Dawson, et al. (1960) compared the yields of cooked meat from chickens, ducklings, and fryer-roaster turkeys. The turkeys produced the highest yield of cooked meat, including skin and fat, 55 per cent. Yield was the same whether the turkeys were roasted in a 325° oven or braised in a covered roaster in a 450° oven.

The data reviewed in this section seemed to indicate fairly good agreement among the different investigators regarding yield of edible meat.

CHAPTER III

PROCEDURE

In this study two methods of roasting yearling turkey were compared. For this purpose six frozen yearling turkeys were procured through a national-chain supermarket. These birds were U. S. Government Inspected birds packed by Swift and Company. Each weighed approximately 16 pounds.

For each test, a single frozen turkey was sawed in half lengthwise. The halves were thawed at room temperature for eight hours and then covered with saran-wrap and set in a refrigerator overnight to complete thawing. However, three tests were conducted on days which required that the halves be set out at room temperature for three and one-half hours and placed in a refrigerator for 43 1/2 hours. On Test IV, the halves had been thawed for testing on the previous day, but due to the absence of several panel members, they had to be refrigerated for an additional 24 hours. Thus, conditions for thawing were not as controlled as had been planned.

After thawing, the neck, giblets, and excess fat were removed. Each half was washed with a damp cloth, pinfeathers were removed, and a coating of melted margarine was brushed on. The raw weight of each half bird was determined by weighing on a torsion balance. Since it was impossible to divide the turkeys into exactly equal halves, the larger half was alternated between the two methods of roasting to equalize the effect of bird size on cooking time, cooking losses, power

consumption, and yield of edible meat.

A metal skewer was inserted at the thickest part of the pectoralis major muscle with the point toward the posterior end of the half bird. The half which was to be roasted by the open-pan method was placed in a tared shallow pan containing a rack. The metal skewer was replaced by a copper and constantan thermocouple.

The turkey half which was to be roasted in aluminum foil was placed in a similar pan, without a rack, but with enough aluminum foil to wrap the half bird. The thermocouple was inserted into the breast muscle as for the open-pan method. The bird was wrapped in the foil, with the dull side next to the bird and the edges were loosely sealed. Cooking was started when the internal temperature of the breast muscles was 40 to 48° F as measured on a Leeds-Northrup potentiometer.

I. COOKING PROCEDURES

The cooking procedures in general were the same as those used by Majhor (1962), in a similar study on young turkeys. The procedure for the open-pan method was recommended by the Poultry and Egg National Board (1954), with the exception that cooking was started in a cold oven. The procedure for the foil-wrap method was the High Temperature, Quick method recommended by the Reynolds Metal Company (1961), again starting in a cold rather than a preheated oven. Cold ovens were used in order to obtain a record of total power consumption for each method.

The ovens of two household electric ranges were used for

roasting the turkey halves. The ovens were alternated for the two methods of roasting to equalize the effect of any thermostat variation in the two ovens.

A watt-hour meter was attached to the power line of each oven and the initial reading was recorded. When each half reached an internal temperature of 40 to 48° F, as measured by the potentiometer, the temperature was recorded and the roasting was started. Roasting was done at 325° F for the open-pan method and at 450°F for the foil-wrap method. A record was made of the total cooking time.

A potentiometer measurement of the internal temperature of each breast muscle was recorded every five minutes. When the internal temperature of the foil-wrapped half reached 180° F, the foil was turned back to allow for browning, and the thermocouple was pushed in slightly to verify the temperature. To make a comparable effect on power consumption, the door of the 325° F oven was opened and the thermocouple pressed down once during each roasting. For both methods, roasting was continued until the internal temperature of the breast muscle reached 198° F. The halves for Test I were roasted to an end-point of 194° F, but the judges indicated that the meat was tough and underdone. Thus, for the remaining five tests an end-point of 198° F was used. At this point the ovens were turned off and the half birds were removed from the ovens. The final reading of the watt-hour meter was recorded.

II. DETERMINATION OF COOKING LOSSES, EDIBLE YIELD, SHEAR VALUES, AND POWER CONSUMPTION

After cooling for 30 minutes, the weight loss due to evaporation

was determined by subtracting the final weight of pan, rack or foil, and cooked turkey half from the initial weight of pan, rack or foil, and raw turkey half. The roasted half was then removed from the pan and the weight loss due to drippings was determined by weighing pan, with rack or foil, and drippings and then subtracting the weight of the pan and rack or foil. Total cooking losses were calculated by adding the evaporation and drippings losses.

In order to determine the yield of edible meat for each method of roasting, all meat was removed from the bones. It was separated into muscle, skin with adhering fat, and bones. Each portion was weighed and weight recorded. The percentage of edible meat, excluding skin, was calculated on the basis of the oven-ready weight of the half bird.

Objective tenderness determinations were made by shearing five corresponding cores from each half bird. The pectoralis major was cut across the grain at the broadest point of the muscle. Three half-inch cores were removed parallel to the grain, boring from the cut surface toward the anterior end of the muscle. Two similar cores were removed toward the posterior end. These cores were sheared on a Warner-Bratzler shear apparatus. Three shears were made on each core and the 15 values were averaged for each half bird.

From the total cooking time, minutes per pound were calculated for each method of roasting. From total watt-hours consumed, the watt-hour consumption per pound was calculated.

III. SENSORY TESTING

A scoring test and a preference test were used to measure acceptability of the turkey roasted by each method. The sensory testing was done by a panel of three women and three men. All but one of the panel members had had previous experience in poultry testing. However, two practice sessions with roasted chicken were used to re-familiarize the panel members with the scoring and preference tests that were to be used.

To begin each test, panel members were given a warm-up sample from corresponding sections of the wing muscle. This sample was alternated between the two methods of cooking and was not scored. For the scoring test, each panel member was given a portion of light and dark meat carved from corresponding locations of the breast and thigh muscles of each turkey half. The samples were coded so the judges were not aware of which cooking procedure had been used. The meat was scored for flavor, juiciness, and tenderness, using a nine-point scale (Appendix, page 40).

For the preference test, each panel member was given paired samples of light and dark meat representing the two methods of cooking and asked to state a preference for one light and one dark meat sample and give a reason for the selection of each. For both tests, order of presentation of samples was randomized.

IV. ANALYSIS OF DATA

"F" values for cooking time, power consumption, cooking losses and sensory scores were determined by analysis of variance.

CHAPTER IV

RESULTS AND DISCUSSION

I. COOKING TIME AND POWER CONSUMPTION

The cooking time and power consumption for five of the cooking tests are shown in Table I. Since the halves in the first test were roasted to an end-point temperature of 194° F and those for the remaining five tests to 198° F, data on cooking time and power consumption for the first test are not included in this table. Total cooking time was reduced by 41 minutes or approximately 19 per cent when halves were roasted in aluminum foil. Halves roasted by the open-pan method required an average 29.4 minutes per pound, while foil-wrapped halves required 24.4 minutes per pound. This difference was significant ($P = 0.05$).

A highly significant difference in power consumption was found between methods of roasting ($P = 0.01$). The foil-wrapped halves required an average of 468 watt-hours per pound, and open-pan halves required 354 watt-hours per pound. Thus, roasting in foil increased the power consumption about 0.1 kilowatt-hour per pound. This represents an approximate 28 per cent increase in total power consumption when roasting by the foil-wrap method. These results are in close agreement with those reported by Majhor (1962) for roasting young turkeys in foil.

TABLE I

COOKING TIME AND FUEL CONSUMPTION FOR ROASTING
YEARLING TURKEY BY TWO METHODS

Test Number	Raw Weight		Cooking Time				Fuel Consumption			
			Total Time		Min/lb		Total Watt-hrs		Watt-hrs/lb	
	Open Pan lb	Foil Wrap lb	Open Pan (min)	Foil Wrap	Open Pan	Foil Wrap	Open Pan	Foil Wrap	Open Pan	Foil Wrap
II	7.6	6.6	217	168	28.6	25.4	2500	3257	329	494
III	7.1	7.7	180	206	25.4	26.6	2389	3699	336	480
IV	7.2	7.3	196	157	27.1	21.6	2251	3095	311	426
V	7.2	6.3	217	166	30.0	26.6	2786	3063	385	490
VI	6.8	7.1	245	154	36.0	21.7	2774	3199	408	450
Average	7.2	7.0	211	170	29.4*	24.4*	2540	3263	354**	468**

*Significant, P = 0.05

**Significant, P = 0.01

II. COOKING LOSSES

Data on percentage evaporation, drippings losses, and total cooking losses are presented in Table II. Since different end-point temperatures would probably affect cooking losses, the data for Test I are not included in this table. Evaporation, drippings, and total cooking losses did not differ significantly between the two methods of roasting. Evaporation loss averaged 18.8 per cent for the open-pan method and 15.9 per cent for the foil-wrap method. Average loss due to drippings was 20.4 per cent for the foil-wrap method and 18.4 per cent for the open-pan method. Total cooking losses averaged 37.2 per cent for the open-pan method and 36.2 per cent for the foil-wrap method. None of these differences were significant.

III. YIELD OF EDIBLE MEAT

Since a slight difference in end-point temperature (194 to 198° F) was not expected to appreciably affect the yield of edible meat, tenderness, or palatability, data for these factors from all six tests are included. Data for yield of edible meat are presented in Table III. Only percentages of edible meat excluding skin are shown in this table since the cooked skin was considered undesirable. The author observed a tendency for skin to adhere to the muscle after roasting. The foil-wrapped halves produced approximately the same yield of edible meat, averaging 39.6 per cent, as the open-pan halves which averaged 38.6 per cent. These differences were not significant. Therefore, in this study, method of roasting had no effect on yield of cooked edible meat from yearling turkey.

TABLE II

PERCENTAGE COOKING LOSSES OF YEARLING TURKEY ROASTED BY TWO METHODS

Test Number	Evaporation Loss		Drippings Loss		Total Cooking Losses	
	Open Pan	Foil Wrap	Open Pan	Foil Wrap	Open Pan	Foil Wrap
II	16.7	15.2	19.1	19.5	35.8	34.6
III	15.4	21.3	16.4	12.9	31.8	34.2
IV	17.2	12.3	21.1	23.2	38.3	35.5
V	21.1	18.4	19.1	21.8	40.2	40.1
VI	23.8	12.2	16.4	24.5	40.1	36.7
Average	18.8	15.9	18.4	20.4	37.2	36.2

TABLE III

YIELD OF EDIBLE MEAT[a] FROM YEARLING TURKEY ROASTED BY TWO METHODS

Test Number	Raw Weight (gm)		Yield of Cooked Meat (gm)		Percentage Yield of Cooked Meat	
	Open Pan	Foil Wrap	Open Pan	Foil Wrap	Open Pan	Foil Wrap
I	3467	3122	1336	1200	38.5	38.4
II	3456	3009	1238	1232	35.8	40.9
III	3226	3512	1292	1317	40.1	37.5
IV	3282	3295	1329	1333	40.5	40.5
V	3287	2837	1200	1110	36.5	39.1
VI	3091	3226	1248	1329	40.4	41.2
Average	3302	3167	1274	1254	38.6	39.6

[a]Excluding skin and adhering fat

IV. SHEAR VALUES

Data for average shear values of light meat roasted by the two methods are presented in Table IV. Average shear values for the foil-wrap method, 5.4 pounds, were approximately the same as those for the open-pan method, 5.2 pounds. There was considerable range in the shear values among the six tests for each method of roasting. It was felt that differences in the amount of connective tissue in each turkey probably accounted for this variation in shear values. The difference in shear values for the two methods of cooking was not statistically significant, indicating that no benefit in tenderness was achieved by roasting turkey wrapped in aluminum foil.

V. SENSORY TESTS

Scoring Tests

Data on sensory scores for light and dark meat are presented in Table V. Light meat from the open-pan method was scored significantly higher for flavor than that from the foil-wrap method ($P = 0.01$). No significant differences were found in flavor scores for dark meat, although the open-pan samples averaged slightly higher.

Juiciness scores for both light and dark meat differed significantly ($P = 0.05$) between the two methods of cooking, open-pan samples scoring higher. The difference in juiciness was more marked in the light meat.

No significant differences were found in tenderness scores for light meat, although samples from the open-pan method averaged slightly

TABLE IV

AVERAGE SHEAR VALUES FOR LIGHT MEAT FROM
YEARLING TURKEY ROASTED BY TWO METHODS

Test Number	Open Pan	Foil Wrap
I	4.5	4.9
II	3.7	5.8
III	7.5	8.0
IV	5.2	4.5
V	4.5	3.8
VI	5.9	5.7
Average	5.2	5.4

TABLE V

PANEL SCORES FOR LIGHT AND DARK MEAT OF YEARLING TURKEY ROASTED BY TWO METHODS

Test Number	Flavor				Juiciness				Tenderness			
	Light Meat		Dark Meat		Light Meat		Dark Meat		Light Meat		Dark Meat	
	Open Pan	Foil Wrap	Open Pan	Foil Wrap	Open Pan	Foil Wrap	Open Pan	Foil Wrap	Open Pan	Foil Wrap	Open Pan	Foil Wrap
I	7.2	6.5	7.2	6.8	6.2	5.0	6.7	6.5	6.7	6.0	7.0	6.2
II	7.3	6.8	7.2	7.0	6.3	5.8	7.0	6.7	7.2	6.2	7.7	6.8
III	7.2	6.8	7.3	7.0	6.3	6.2	6.8	6.5	6.7	6.8	7.5	7.2
IV	7.0	6.7	7.2	7.2	5.8	5.3	6.8	6.3	7.2	6.8	7.5	7.5
V	7.5	6.8	7.5	7.0	7.2	5.8	7.2	6.7	7.5	7.3	8.0	7.2
VI	7.2	7.3	7.7	7.5	6.5	5.7	6.8	6.8	7.5	7.0	7.8	7.0
Average	7.2**	6.8**	7.4	7.1	6.4*	5.6*	6.9*	6.6*	7.1	6.7	7.6*	7.0*

**Significant, P = 0.01

*Significant, P = 0.05

higher. Both objective and subjective tests, therefore, indicated that the method of cooking did not significantly affect the tenderness of light meat. However, dark meat, which was not tested objectively scored significantly lower in tenderness ($P = 0.05$) on subjective tests when roasted in aluminum foil.

Average scores for flavor, juiciness, and tenderness of meat from both methods of roasting ranged from fair-plus to good. Thus, while significant differences were obtained for flavor of light meat, juiciness of light and dark meat, and tenderness of dark meat, the magnitude of the difference was very slight. This raises a question of how these results should be interpreted for consumers. It was noted that the dark meat scored higher than the light meat on all three characteristics tested, irrespective of the method of cooking. There seems to be no obvious reason for this finding. It might be pointed out, also, that none of these yearling turkeys were scored excellent in tenderness, juiciness, or flavor by the panel employed in this study.

Preference Tests

Following the scoring tests, panel members were given light and dark meat samples from each method of roasting and asked to state a preference for one light and one dark meat sample. These preference tests indicated that light and dark meat from the open-pan method was highly preferred. In the 36 tests, the preference for light meat from the open-pan roasting was 63.8 per cent and for the dark meat, 75.0 per

cent. Light meat from the foil-wrap method was preferred 30.5 per cent of the time and dark meat, 22.2 per cent of the time. No preference was stated for two light meat samples and one dark meat sample. It is difficult to explain the high percentage of preference for the open-pan method in view of the slight differences in scores for the two methods. Apparently the slight differences in juiciness, tenderness, and flavor were sufficient to influence preference.

VI. HEAT PENETRATION

Heat penetration data were obtained from measurements of internal temperature of the pectoralis major muscle in the breast taken at five-minute intervals on a Leeds-Northrup potentiometer. The heat penetration curves were derived by averaging data for four tests from each method which required approximately the same amount of total cooking time. This average internal temperature was plotted against time in minutes. Data for both methods of cooking are shown in Figure 1. It was observed that there was a slower rise in temperature during the early part of cooking in the foil-wrapped halves. However, after 30 minutes, the foil-wrapped halves achieved and maintained a higher internal temperature than the open-pan halves roasted for the same length of time.

VII. EXTERNAL APPEARANCE

Observations were made of these yearling turkeys before and after roasting. The thawed birds were chalky white in color and had coarse, thick skin with large pores. The birds appeared to have a higher degree

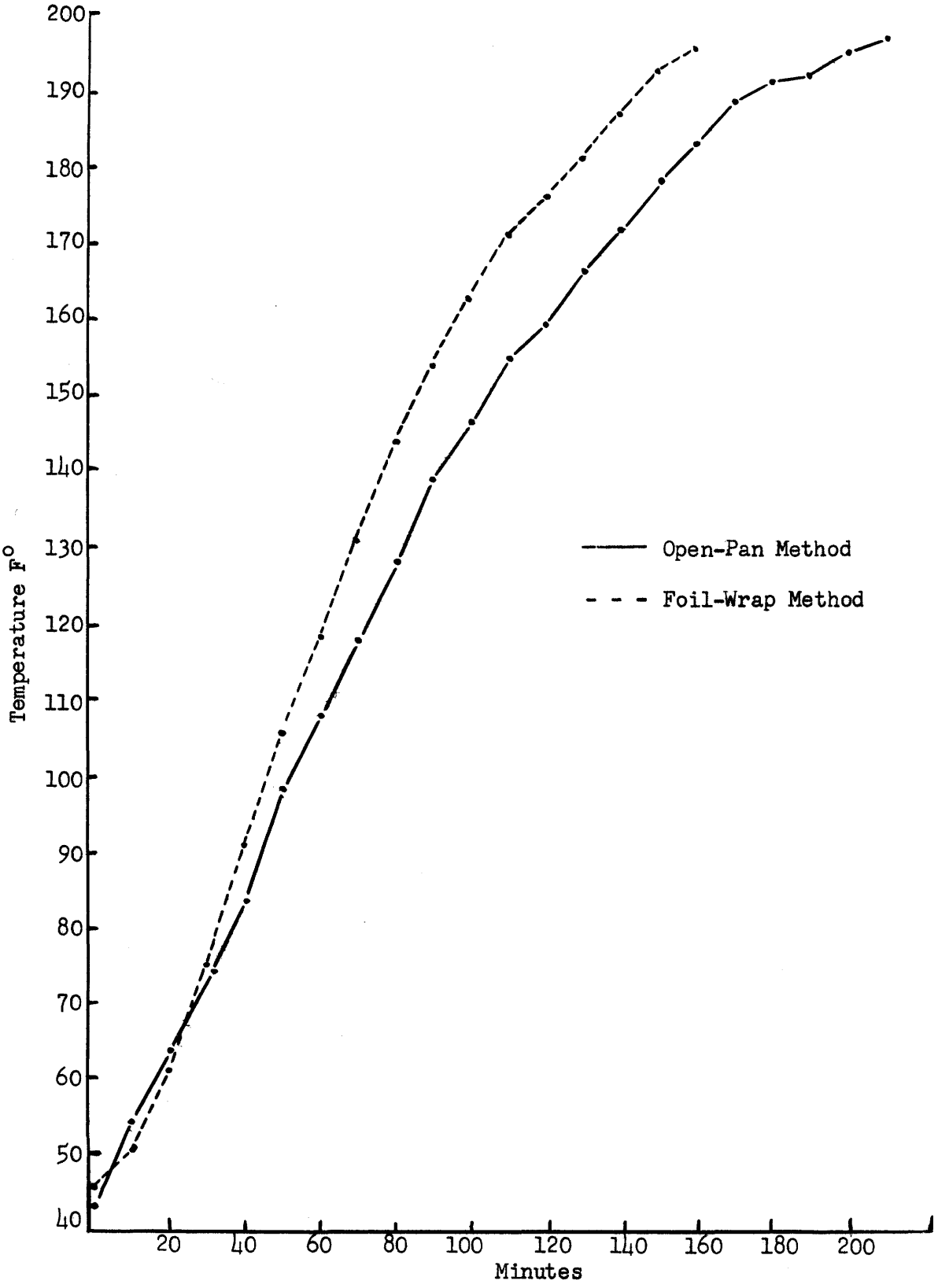


Figure 1. Heat penetration in yearling turkey halves roasted by two methods.

of fat adhering to the skin than is found in young turkeys. Following roasting, there were no observable differences in the browning of halves cooked by either method, both yielding desirably browned products. The skin of these yearling birds was tough and dry after roasting by either method.

VIII. DISCUSSION

The results reported in this study are in close agreement with those reported by Majhor (1962) and by Lowe (1953). In all three studies, cooking in foil resulted in a shortened cooking time. When halves were roasted in aluminum foil, total cooking time was reduced about 25 per cent in Majhor's study and about 19 per cent in the present study. In both Majhor's and the author's studies, cooking in foil at 450° F increased the power consumption approximately 0.1 kilowatt-hour per pound and total power consumption was increased 28 to 29 per cent.

Dripping loss reported by Majhor (1962) for young turkeys was approximately half the amount found in this study. In the present study, the skin was slashed between the thigh and the body after roasting to allow complete draining before the necessary weights were taken. This probably was a factor in the greater drippings and total cooking losses obtained. Although Lowe indicated that cooking in foil gave more drippings for making gravy, the slight increase in drippings was not significant in the present study.

Flavor of light meat, juiciness of light and dark meat, and tenderness of dark meat from the open-pan method were scored significantly

higher in this study. However, the actual scores averaged less than one point higher for the open-pan method for all three characteristics: flavor, juiciness, and tenderness. Therefore, it is difficult to interpret these data from a consumer standpoint. Both methods might be considered as yielding acceptable products, since shear values and scores for tenderness of light meat did not differ significantly between the two methods. These results are approximately the same as those reported by Majhor (1962).

In both studies, there was a high percentage of preference for light and dark meat roasted by the open-pan method. Apparently, the slight differences in juiciness, tenderness, and flavor scores were sufficient to influence preference.

Results of tests for tenderness of light and dark meat in the present study tend to disprove the hypothesis that cooking in foil promotes an increase in tenderness. It would seem that cooking in foil did not promote the breakdown of collagen. However, chemical tests would be required to prove this point.

Since neither method of roasting used in this study resulted in excellent quality products, it would be of value to investigate whether moist-heat methods of cooking, such as braising and pressure cooking, would be more suitable for yearling turkeys.

CHAPTER V

SUMMARY

I. SCOPE OF THE STUDY

The purpose of this study was to compare the effects of roasting fully matured yearling turkeys by open-pan and foil-wrap methods. It was based on the hypothesis that cooking poultry in aluminum foil holds in the steam and, therefore, increases tenderness. The test products consisted of six yearling turkeys procured through a national-chain supermarket. Tests were conducted in the winter of 1963.

Data were obtained on cooking losses, power consumption, cooking time, yield of edible meat, shear values and heat penetration. Estimates of tenderness, juiciness, flavor, and consumer preference were obtained through sensory tests.

II. PRINCIPAL FINDINGS

Results of the tests indicated that roasting yearling turkey halves at 450° F wrapped in aluminum foil significantly reduced the required cooking time by about 19 per cent and significantly increased the total power consumption about 28 per cent or about 0.1 kilowatt-hour per pound. However, method of roasting had no significant effect on evaporation, drippings, and total cooking losses nor on yield of edible meat and shear values.

Flavor of light meat, juiciness of light and dark meat, and tenderness of dark meat from the open-pan method were scored significantly higher by an experienced taste panel. However, the actual scores averaged less than one point higher in favor of the open-pan method for all three characteristics: flavor, juiciness, and tenderness. In spite of the slight differences in scores, on preference tests there was a high percentage of preference for both light and dark meat cooked by the open-pan method. Therefore, it is difficult to interpret these data from a consumer standpoint. Both methods might be considered as yielding acceptable products, since the differences in the sensory scores were so slight.

III. CONCLUSION

Both shear tests and panel scores indicated that there was no difference in tenderness of light meat roasted by either method. Dark meat roasted in aluminum foil was scored significantly less tender. These findings tend to disprove the hypothesis that cooking in foil promotes an increase in tenderness. Based on the findings of this study, it would seem that the chief advantage of roasting yearling turkey in foil is the decrease in cooking time achieved.

BIBLIOGRAPHY

BIBLIOGRAPHY

Anonymous. 1954. "Golden Treasury of Turkey Cookery." Poultry and Egg National Board, Dept. of Home Economics, Chicago, Ill.

Anonymous. 1961. "Poultry Roasting with Reynolds Wrap." Reynolds Metal Company, Eastern Public Relations Office, New York, N. Y.

Alexander, L. M. 1941. Poultry cooking. U. S. Dept. Agr. Farmers' Bull. No. 1888.

Alexander, L. M., G. E. Schopmeyer, J. C. Lamb, and S. J. Marsden. 1951a. Turkey temperature as the end point of roasting. Poultry Sci. 30, 520.

Alexander, L. M., G. E. Schopmeyer, J. C. Lamb, and S. J. Marsden. 1951b. Yield of cooked edible portion for young Beltsville small white turkeys. Poultry Sci. 33, 775.

Dawson, E. H., E. F. Dochterman, and R. S. Vettel. 1958. Food yields in institutional food service. J. Am. Dietet. Assoc. 34, 371.

Dawson, E. H., G. L. Gilpin, and A. M. Harkin. 1960. Yield of cooked meat from different types of poultry. J. Home Econ. 52, 445.

Goertz, G. E., K. Cooley, M. C. Ferguson, and D. L. Harrison. 1960a. Doneness of frozen defrosted turkey halves roasted to several end point temperatures. Food Technol. 14, 135.

Goertz, G. E., A. S. Hooper, and D. L. Harrison. 1960b. Comparison of rate of cooking and doneness of fresh-unfrozen and frozen, defrosted turkey hens. Food Technol. 14, 458.

Goertz, G. E. and S. Stacy. 1960. Roasting half and whole turkey hens. J. Am. Dietet. Assoc. 37, 458.

Goertz, G. E., B. Weathers, D. L. Harrison, and P. E. Sanford. 1961. Tenderness scores and Warner-Bratzler shear values for broilers and Beltsville white turkeys fed different cereal grains. Poultry Sci. 40, 488.

Goodwin, T. L., V. D. Bramblett, G. E. Vail, and W. J. Stadelman. 1962. Effects of end point temperature and cooking rate on turkey meat tenderness. Food Technol. 16, 101.

Hauver, Jr., W. E., and L. Kilpatrick. 1961. Poultry grading manual. Agr. Marketing Service, Poultry Division, U. S. Dept. Agr. Handbook No. 31.

Klose, A. A., M. F. Pool, M. B. Wiele, H. J. Hanson, and Hans Lineweaver. 1959. Poultry tenderness. I. Influence of processing on tenderness of turkeys. Food Technol. 13, 20.

Lowe, B., and F. Keltner. 1937. Studies in cooking frozen poultry. U. S. Egg and Poultry Magazine 43, 296, 314.

Lowe, B., M. Edgar, F. Schoenleber, and J. Young. 1953. Cooking turkey in aluminum foil. Iowa Farm Sci. 8, 326.

Lowe, B. 1955. "Experimental Cookery." 4th ed. John Wiley and Sons, Inc., New York, New York.

Majhor, A. J. R. 1962. A comparison of roasting turkey by an open-pan and a foil-wrap method. M. S. Thesis. University of Tennessee Library, Knoxville, Tennessee.

Niles, K. B. 1936. Turkey cookery. U. S. Egg and Poultry Magazine 42, 742.

Swickard, M. T., and A. M. Harkin. 1954. Percentage relationships of raw carcass weights and yield of cooked edible portion for young Beltsville small white turkeys. Poultry Sci. 33, 775.

Swickard, M. T., R. S. Mainland, and S. J. Marsden. 1961. Turkey on the table the year round. U. S. Dept. Agr. Home and Garden Bull. No. 45.

Winter, A. R., and P. Clements. 1957. Cooked edible meat in ready-to-cook poultry. J. Am. Dietet. Assoc. 33, 800.

APPENDIX

DATA ON COOKING AND COOKING LOSSES OF TURKEYS

Test No:	Date:	
Treatment		
Pan No.		
	gms.	gms.
A. Before cooking:		
1. Wt. of pan and rack or foil		
2. Wt. of half bird		
3. Total wt. before cooking		
B. After cooking:		
1. Total wt. of pan, bird and rack or foil		
2. Wt. loss due to evaporation (A3 - B1)		
3. Wt. of pan, drippings and rack or foil		
4. Wt. of pan and rack or foil		
5. Wt. of drippings (B3 - B4)		
6. Total cooking losses (B2 + B5)		
C. Cooking data:		
1. Time into oven		
2. Time out of oven		
3. Total cooking time (min.)		
4. Wt. of half bird in lbs.		
5. Time per pound		
D. Percentage cooking losses:		
1. Loss due to evaporation (B2/A2 x 100)		
2. Loss due to drippings (B5/A2 x 100)		
3. Total loss (D1 + D2) or (B6/A2)		

POWER CONSUMPTION DATA

Test No._____

Date_____

Treatment	Oven Open Pan	Oven Foil Wrap
Final reading		
Initial reading		
Total watt-hrs consumed		
Watt-hrs/lb		

YIELD OF EDIBLE MEAT

Test No._____ Date_____

	Open Pan	Foil Wrap
Raw weight		
Cooked weight of bird		
Weight of edible meat		
Weight of skin		
Weight of waste		
Total		
% loss due to boning		
% edible meat		
% edible meat with skin		
Total cooking losses		

SHEARING TESTS

Test No._____ Date_____

	Open Pan					Foil Wrap				
Core No.	1	2	3	4	5	1	2	3	4	5
1st Shear										
2nd Shear										
3rd Shear										
Total										
Average										
Sample Average										

GRADING CHART FOR MEAT

Date_____ Name_____

Directions: Give full value for excellent quality.
Do not use fractional points.

Values: 9 - Excellent
8 - Very good
7 - Good
6 - Fair plus
5 - Fair
4 - Fair minus
3 - Poor
2 - Very poor
1 - Extremely poor

Sample No.				
Flavor				
Juiciness				
Tenderness				

Comments:

PREFERENCE TEST

Name_____ Date_____

Select a preference from each pair.

	Choice	Reason
Pair I		
Pair II		